POWER

Volume 63 New York, January 12, 1926 *No.* 2

Power-Plant Charges

SOME of the more partisan agitators for the extinction of the industrial power plant insist that interest upon the capital invested in it be charged, not at the rate at which money can be borrowed, but at the rate at which such capital can be made to earn profit in other departments of the business.

It does not make much difference how such accounts are kept or what, outside of the pertinent items, is included in them, so long as the man whose judgment is influenced by them knows what they mean.

If everybody who uses or refers to the estimated or recorded cost of industrial power understands that it includes a guess at what the capital involved might have earned if otherwise employed, he may not fool himself.

If such an item is used to inflate the apparent cost of private-plant operation for comparison with the cost of purchased power, it may lead one who does not analyze the details of the computation into an unwise and costly decision.

The safe, sane and sensible method would seem to be to include in the cost of private production all those items, but only those items, that involve actual expense; the interest actually paid for borrowed capital or at which capital could be borrowed instead of withdrawn or withheld from other investments, for example.

Then if the purpose of the account is to determine the comparative cost of home-made or purchased power, check off the actual reduction in each of these items which will result from shutting down the power-generating portion of the plant.

How much less will it actually cost for rent and administration? How much will the capital actually invested be reduced?

This will show how much it will cost to run in each of the two ways, the power cost will be comparable with the power costs of others, and the executive can judge intelligently whether he had better make the necessary investment for the profit, if any is indicated, of making his own power, or whether he had better invest it in productive plant or Florida real estate.

The argument for other possibly more profitable uses of the money is pertinent, but a guess at the rate of interest that it may be made to earn is not a legitimate item in an estimate or record of the cost of carrying on an industrial power plant.

F. R. Low

Wood Refuse Burned on Underfeed Stokers

By C. M. Garland
Consulting Engineer, Chicago

Modern 1,300-kw. turbine plant operated non-condensing to meet demand for heating and process steam. With cheap fuel the boiler room is of simple design. Either bituminous coal or wood refuse is burned on underfeed stokers. System of handling wood refuse provides safety and flexibility.

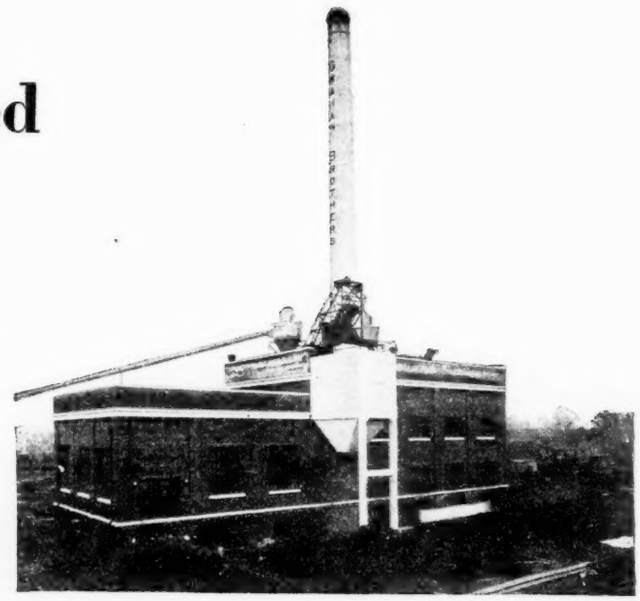


Fig. 1—Refuse is conveyed to a cyclone on the roof

Located at Evansville, Ind., the plant of Graham Brothers is used for the manufacture of the well-known Graham trucks. In the manufacturing operation electrical energy is required for machine shops, woodworking shops, for driving fans for heating, fans for the handling of wood refuse, lights and other miscellaneous purposes. At the same time low-pressure steam is needed the year around for the operation of dry kilns and enameling ovens.

The manufacturing plant is expanding rapidly and at the present time during the eight-hour working period, the average load is about 400 kw., with a peak of about 600 kw. However, for a large part of the time this power load extends over 16 hours. During the non-working period the load varies from 50 to 100 kw., depending upon weather conditions largely, as hot-blast systems are used throughout the plant for heating.

Steam for heating during the winter months is used in some departments, particularly the paint shops, 24 hours a day. Since the factory buildings are provided with a saw-tooth roof construction, the steam requirements for heating are large. At the present time these demands vary from 24,000 to 36,000 lb. of steam an hour, as a maximum, depending upon outside weather conditions. During the summer months from 9,000 to 12,000 lb. of steam an hour is used for heating dry kilns and enameling ovens, while the total steam requirement during the summer months averages close to 21,000 lb. an hour. Of the total steam generated, approximately 9,000 lb. can be produced from the wood refuse available.

Steam for dry kilns during the summer months is delivered under a pressure of 2 lb. per sq.in. and at 5 lb. during the winter. It is generated at a pressure of 200 lb. gage with no superheat.

The fuel available in this section is Indiana and West Kentucky coal. The Indiana coal is a low-grade fuel, and while the West Kentucky coal is somewhat better, the price is a little higher. In either case a charge in the neighborhood of $2 a ton insures a low fuel cost. Besides, wood refuse is available from which nearly one-half of the summer requirements for steam can be generated.

Owing to the comparatively low cost of the coal and the supply of wood refuse, a boiler plant of the highest efficiency would not pay a proper return on the investment. For this reason economizers, air preheaters and superheaters were not installed, although provision was made for superheaters should the future development of the plant warrant their installation.

Two V-type boilers equipped with underfeed stokers comprise the initial installation. Above each stoker in the front of the boiler setting a windbox has been provided with 1-in. discharge nozzles spaced on 12-in. centers across the front of the boiler setting. These nozzles discharge air across the top of the fire when wood refuse is being burned. The stokers are designed for the development of approximately 250 per cent boiler capacity when operating on screenings. They are equipped with individual forced-draft fans driven by steam turbines. The furnace volume is somewhat larger than would have been necessary for the burning of coal alone. As the steam requirements did not warrant the installation of more than two boilers, it was therefore necessary to equip each boiler for the burning of either wood refuse or coal.

Wood refuse from the wood-working plant is conveyed through an overhead system to a cyclone located on the roof of the boiler house. This cyclone discharges into a V-shaped bin located between the boiler room and the turbine room and adjacent to the hoisting shaft. The bin is of fireproof construction and has sufficient capacity to store approximately two days' run of wood refuse. A drag conveyor of the chain type is located in the bottom of the bin and is adapted to discharge the wood refuse into a down spout leading to the suction side of the fan. This fan discharges to an auxiliary cyclone located over the boiler room, which in turn delivers by two independent spouts to either one or to both of the two boilers.

The main cyclone receiving the wood refuse from the mill also is provided with a down spout which

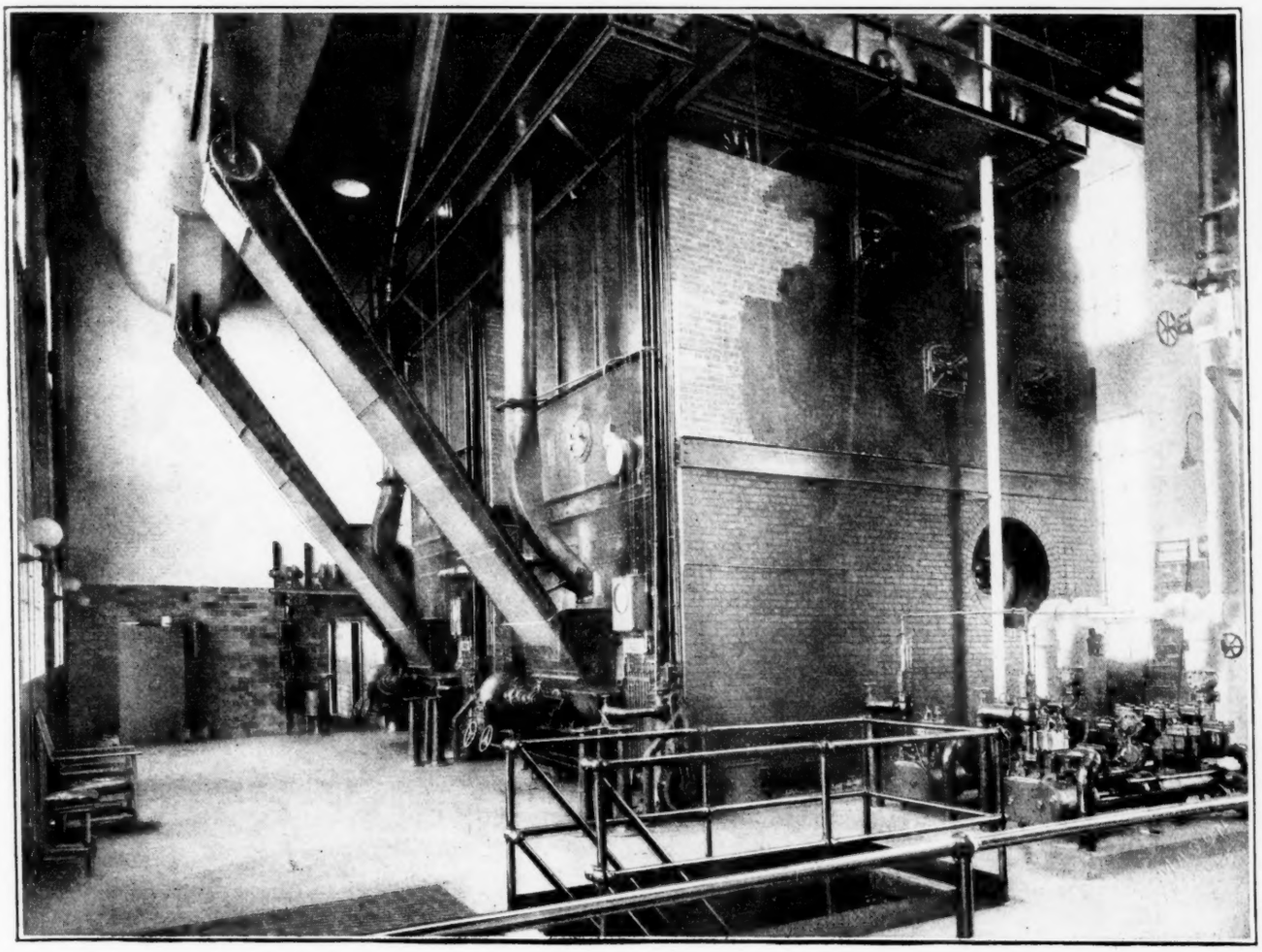


Fig. 2—Note the chutes for feeding coal and wood refuse to the underfeed stokers

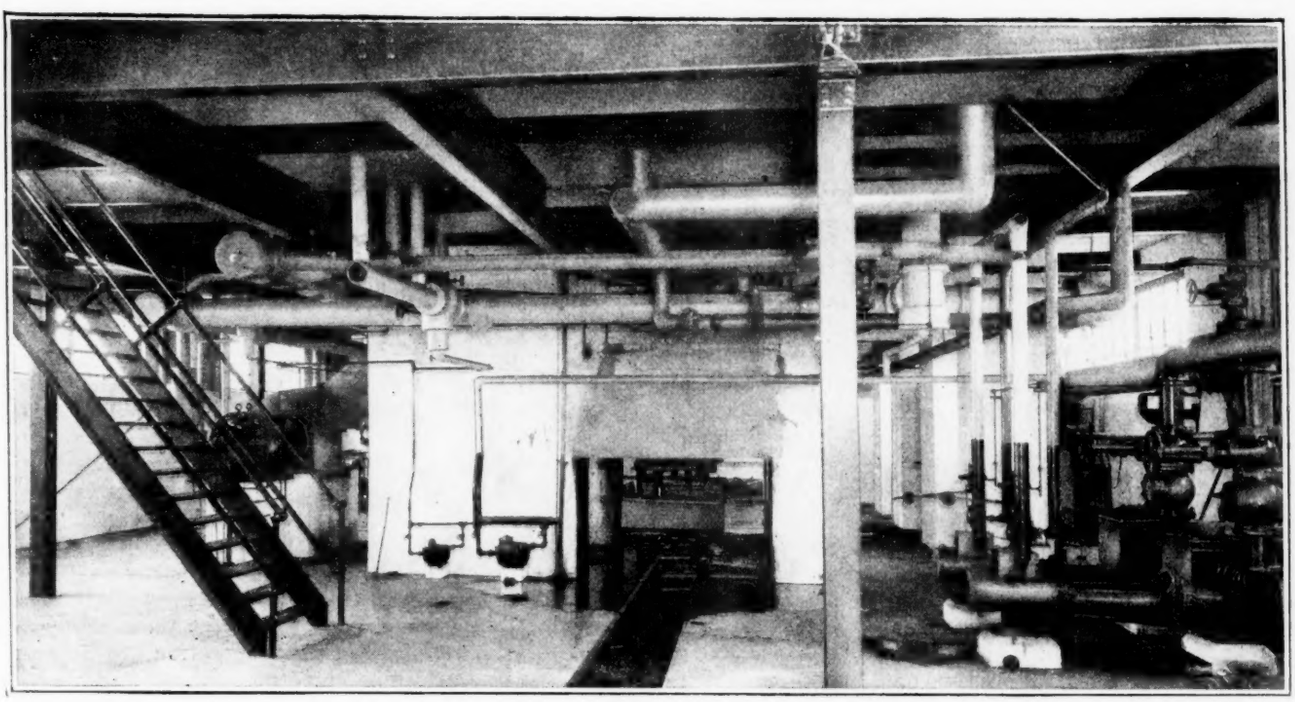


Fig. 3—Boiler-room basement with car under ash hopper

bypasses the main storage bin, so that in case of an emergency the wood refuse can be discharged direct to the fan located in the basement. Normally, however, the wood refuse is delivered to the storage bin and then unloaded by means of the drag conveyor, as previously described.

This arrangement of handling the wood refuse is perhaps more elaborate than is ordinarily provided, but for safety and flexibility was considered desirable. There is always danger of sparks from the furnace passing up the wood refuse pipe leading to the cyclone and causing an explosion which may effect considerable damage. With the present arrangement it is believed unlikely that an explosion would extend farther than the auxiliary cyclone on the roof of the boiler house. In addition to this wood refuse can be handled in an emergency in any manner that would seem to be most desirable. When the next unit is installed, one boiler will be set aside for the burning of wood refuse and the setting will be designed especially for this purpose.

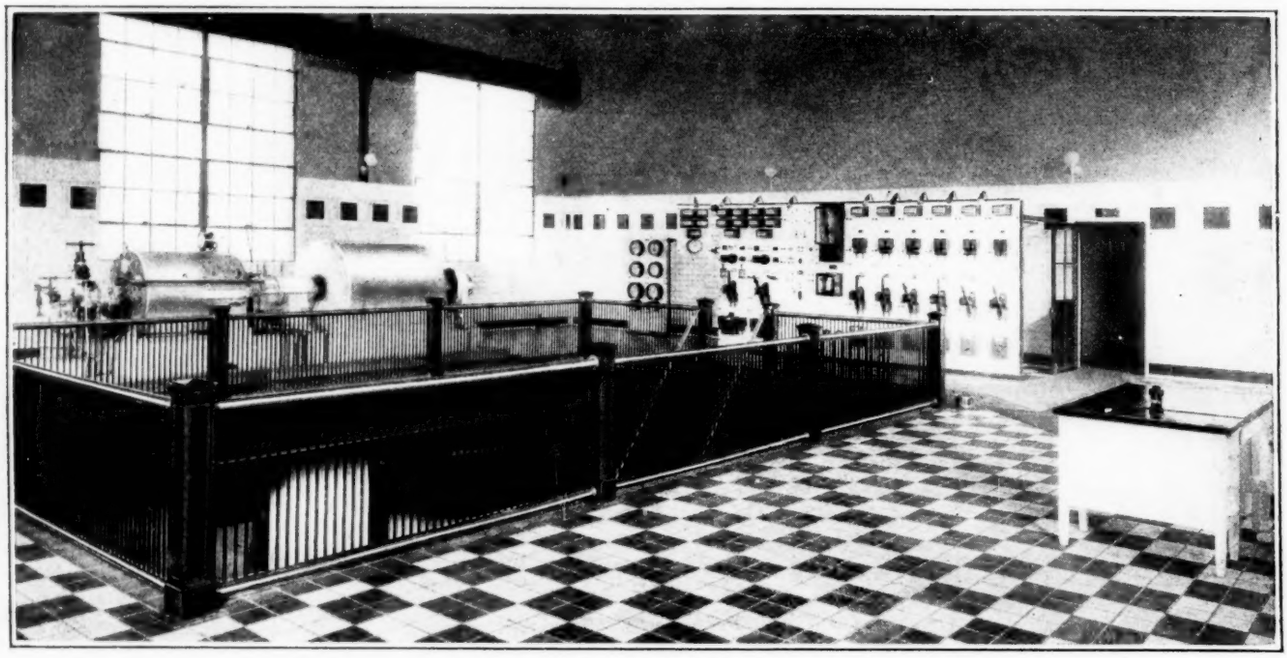


Fig. 4—A most attractive turbine room in which the turbines are enameled white

The wood refuse used is all from kiln-dry material, so that it burns rapidly. It has been found that the stokers handle this fuel satisfactorily without coal. As a matter of fact, during the entire summer the plant has been operated on wood refuse alone without any appreciable damage to the grates. The principal difficulty has been in keeping down the smoke when burning wood refuse and coal at the same time without a large excess of air.

By the uniform distribution of wood refuse over the grate area and its uniform feeding, together with proper draft regulation, the smoke nuisance practically has been eliminated. In designing a furnace of this type for handling of either coal or wood refuse, a compromise necessarily must be effected. In the present case this compromise has worked out better than was anticipated.

Coal handling in this plant also is of interest. The coal is received in cars on a siding adjacent to the plant and is dumped into a track bin under the ash hopper, having a capacity of approximately 50 tons of coal. This coal is passed over a 24-in. apron feeder to a single-roll crusher and from the crusher is delivered to an elevator boot which discharges into an inclosed overhead flight conveyor on the roof of the building. Means are provided for bypassing the crusher when screenings are used. The coal elevator, together with the skip hoist for handling the ashes, passes up through a shaft located in the building between the boiler room and the turbine room. A reinforced-concrete overhead ash hopper is provided for receiving the ash, and the industrial car shown in Fig. 3 handles the ash from the boilers to the skip.

The coal- and ash-handling equipment is designed to take care of approximately 40 tons an hour. No storage space for coal has been provided other than that in the track bin and the overhead bunkers, as there are coal mines in close proximity to the plant. Overhead bins of the continuous type indicated in Fig. 2 are suspended from the roof trusses.

From the flight conveyor over the roof the coal is delivered through chutes that pass through the roof to the overhead coal bunkers, which are provided with semicircular sheet-metal covers for keeping the dust out of the boiler room. The coal-handling equipment is so laid out that future additions to the plant will require only an extension to the flight conveyor located in a housing on the roof, and extensions to the overhead bins.

Raw makeup water for the boilers is Ohio River water taken from the city mains in Evansville. A hot-process water softener was installed on the boiler-room floor underneath the wood refuse bin for the treatment of this water. After six months' operation the boilers have shown practically no signs of scale.

Owing to the comparatively low cost of fuel, the supply of wood refuse which could be disposed of only

by burning under boilers, the large demand for steam for heating during the winter months, and the demand for low-pressure steam during the summer months for dry kilns, it was decided to install, initially, noncondensing turbines, with provision for the installation of condensing equipment on future units, should later developments show that this equipment would pay a proper return on the investment.

Two non-condensing turbine units, designed to operate under a pressure of 200 lb. gage, were selected and directly connected to 2,300-volt three-phase 60-cycle generators. One of the machines has a capacity of

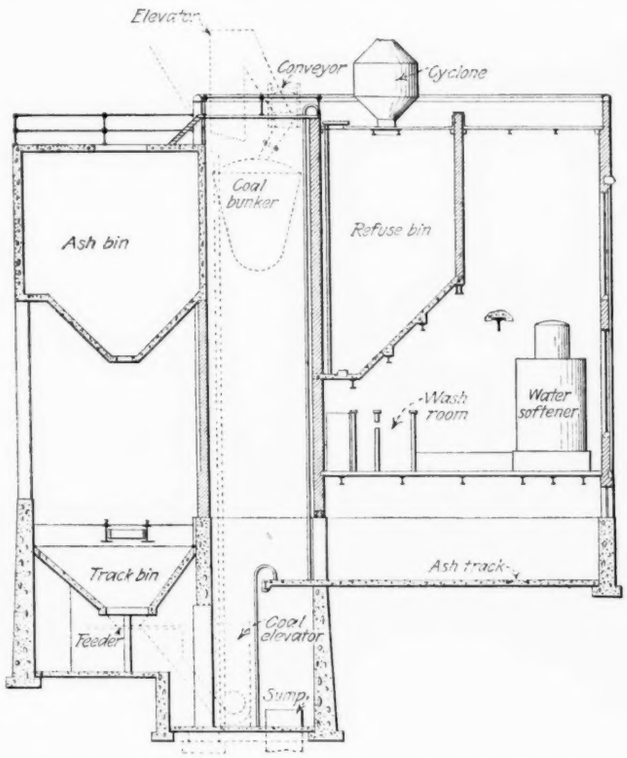


Fig. 5—Section of boiler room showing coal and ash handling

1,000 kw., and the other is rated at 300 kw. The larger unit is designed to carry the load during the working period and the other unit during the non-working period. Owing to the rapid growth of the plant only one large machine was installed, as it was possible that within one or two years conditions in the plant might so change as to warrant the installation either of a larger unit or of a machine of different type. In the event of an accident to the main unit, the small machine will carry the lights, the heating load and some of the shop equipment. In winter months this would necessitate the plant operating on a reduced production schedule which possibly could be made up by 24-hour operation if this were necessary.

When the plant was installed, the current was distributed at 440 volts for power and 220-110 volts for light. As the ultimate capacity of the power plant may reach 5,000 kw. and because of some slight saving to be made in the first cost of the transmission system by distributing at 2,300 volts to substations located throughout the plant and stepping down to 440 volts, it was decided to install 2,300-volt equipment.

The power-house building was designed, first, to meet the requirements of the equipment, and second, to provide ample light, ventilation and a pleasing effect. Like Henry Ford, the Graham brothers are believers in that psychology of environment which subconsciously influences the workman to make the character of his work correspond with his surroundings. For the foregoing reason about 2 per cent of the cost of the outlay was spent in obtaining these results.

In the turbine room the floor is laid up in black and white vitrified tile, while the walls are provided with a white enamel wainscoting with a black sani-onyx base and black and white trimmings. The turbine equipment is enameled in white. Both boiler and turbine rooms are provided with ventilated skylights. The boiler-room doors slide vertically, so that in the summer months the entire boiler-room operating floor can be thrown open to the outside atmosphere.

PRINCIPAL EQUIPMENT OF GRAHAM BROTHERS POWER PLANT

Boilers, two Heine V type, 3,580 sq.ft. ea., 225 lb. working pressure and single settings—Heine Boiler Company.
Stokers, two, underfeed, 3 retort—Westinghouse Elec. & Mfg. Co.
Fans, two, forced draft, driven with Kerr turbines—Buffalo Forge Company.
Chimney, one, reinforced concrete, 8 ft. diam., 200 ft. high—John V. Boland Constr. Co.
Water softener, 3,000 gal. per hour—Graver Corporation.
Pumps, two, 8x5x10-in. American Marsh, end-packed, duplex, plunger type pot valve feed pumps—American Steam Pump Company.
Pumps, two, 8x14x16-in., American Marsh, simplex vacuum pumps—American Steam Pump Company.
Coal handling equipment—Webster Manufacturing Co.
Ash handling equipment, skip hoist—Webster Manufacturing Co.
Turbine, one 1,000-kw. Kerr non-condensing, 200-lb. working pressure—Elliott Company.
Turbine, one, 300-kw. non-condensing 200-lb. working pressure—Kerr Turbine Company.
Generators, 3-phase, 60-cycle, 2,300 volts—Allis-Chalmers Mfg. Co.
Switchboard, remote controlled, hand-operated—Marquette Electric Company.
Instruments—General Electric Company.
Air washer—Bayley Mfg. Company.
Flow meters on turbines—Republic Flow Meters Co.
Flow meters on boilers—Bailey Meter Company.
Recording instruments, for flue gases, feed-water temperature, high-pressure and low-pressure steam—Foxboro Company.

A non-technical bulletin (*R*-13) recently issued by the Leather Belting Exchange Foundation, Cornell University, Ithaca, N. Y., and signed by R. F. Jones, research engineer, contains a variety of practical information on belting. The subjects covered are: Pulley diameters, pulley ratio, center distance, effect of high belt speeds, gravity idler, new rating curves and tables for leather beltings. Since all the findings in this bulletin are based on experimental work, it is significant that the commonly held theories of belt operation are not confirmed at all points. For example, the relation between arc of contact and effective pull as developed in the customary formulas, does not seem to apply unless large corrections are made. These corrections are so many and so complex that the writer recommends depending entirely upon the curves of experimental results.

When an accident occurs and first aid is necessary there is generally no time to consult reference books. Systematic training in first-aid methods has proved of great value in many industries. One of the most practical sources of information on this subject is a bulletin, "First Aid Talks," issued by the Accident Prevention Committee, Technical National Section, National Electric Light Association. Specific instructions are given for first aid in a variety of accidents. Every power plant should have a copy of this report. Another practical booklet on the subject is "First Aid to the Injured," issued by the Travelers Insurance Co., Hartford, Conn.

Care of Refrigerating Brines To Prevent Corrosion*

By Arthur C. White†

THE most generally accepted explanation of all forms of corrosion today is the electrolytic theory, which is based upon the fact that any two dissimilar metals (or electrically conducting materials), immersed in a water solution of any inorganic substance, act as the poles of an electric battery. Therefore, if the two poles are in electrical contact, a current will flow which must alter chemically at least one of the electrode materials, since every combination of metals in a given solution sets up a different voltage, or in other words, presents a source of corrosion of a different strength.

Research Work on Corrosion

For the past two years the Technical Research Department of the Dow Chemical Company has been conducting work on the corrosion of metals used in ice plants, the work having been confined largely to the action of calcium chloride solutions on iron and zinc-coated iron. This work has not been carried on with the intention of proving or disproving any particular theory, but rather in an effort to arrive at the facts and if possible afterward to find theories to fit the conditions revealed by the study.

Early in the work it was recognized that certain products of decomposition or corrosion acted as inhibitors in themselves by forming more or less protective coatings or films on the metals. Furthermore, the character or quality of such films could be varied over a wide range. This quality seems to be characteristic particularly of zinc and is one reason that coating with zinc, or galvanizing, has been used so widely. This metal is easily oxidized or corroded, and such a film, if properly formed, affords real protection against further decay. Zinc is attracted by alkalis and all acids and the character of the coating is easily changed.

Protecting Film on Galvanized Coating

In air, a bright galvanized coating is soon dulled and covered with a firm, adherent layer, consisting largely of zinc oxide and carbonate. This coating or film is much more inert than the metal itself and serves as a decided protection. Zinc is acted upon by alkali to form the hydroxide, which in turn is slowly acted upon by heat, cold, the carbon dioxide of the air, etc., yielding other compounds—mainly the oxides and carbonates already mentioned. These last reactions occur slowly under ordinary conditions, and it was found that if the rate at which the hydroxide was formed could be diminished to nearly the same as that at which the carbonate-oxide layer was formed, it would adhere firmly to the remaining zinc and not easily rub off. If on the contrary the hydrate is produced rapidly by the reaction of a solution having a high alkalinity, the coating is slimy and is easily removed; in fact, it generally falls off, leaving a fresh surface of the zinc metal exposed for attack. This is repeated until finally the zinc is entirely consumed.

These conditions exist in any new plant having galvanized ice cans, as all the calcium on the market today contains varying amounts of soluble alkalinity. If this soluble alkalinity be high, the zinc is quickly converted to the slimy hydrate of zinc.

As long as metallic zinc is present, it is not possible for the iron to be attacked, since it is protected by electrolytic action. For this reason, then, the zinc coating should be preserved as long as possible, a result best obtained by keeping the alkalinity of the calcium low.

In certain installations, where the plant contains no zinc, it has been found that strong gravity brines of high alkalinity tend to corrode iron much less than do those of lower specific gravities and alkalinities. This is due also to a protective film or coating which is deposited upon iron by alkali. The addition of lime or caustic soda solution to such brines as a means of controlling the alkalinity is entirely practical and should be carried out as a matter of routine by the plant engineer at frequent intervals.

It is a fact, however, that brine in the ordinary ice plant seldom needs any added alkalinity—perhaps a small amount once or twice a season. This should be added in small quantities and in rather dilute solutions. In the older ice plants, where the galvanizing has disappeared, it has been found again advantageous to raise the alkalinity by more frequent additions of these same reagents.

There have been numerous patents taken out and numberless cure-alls sold to prevent corrosion, but none of those which we have tested offers complete protection.

Chromium Salts the Best Inhibitors

In the field of so-called inhibitors, chromium salts stand out as the best. The addition of small amounts of these salts, 1 to 5 per cent, cause the metals to become passive to the electro-galvanic action. This passivity may be due to several reasons, but the most plausible theory assumes the formation of an extremely thin film upon the surface of the metal, which acts as a protective coating.

Sodium silicate has been used successfully in hot-water heaters for the formation of just such films, and the use of this material for the prevention of the corrosion of piping systems in laundries, apartment houses and power plants has been of inestimable benefit. This material, however, when employed in a brine solution, undergoes a chemical action and does not produce any protecting film.

By investigation we have found that small amounts of zinc chloride, approximately ½ of 1 per cent, by increasing the zinc concentration of the brine, aid in building up an extremely thin coating of zinc or zinc-iron alloy upon iron surfaces which are in contact with zinc or zinc-coated sheets. After the iron is coated with this film of alloy, the electrolytic action is reduced to a minimum, and therefore the corrosion also is minimized. In making corrosion tests using this compound, carefully weighed pieces of zinc-free iron sheets and galvanized sheets were held in contact by means of a rubber band, and these samples were introduced into calcium chloride brines with and without the addition of zinc chloride. The increase in weight of the iron sheets in the case of the couple immersed in the zinc-calcium brine, together with the identification of the coating as containing metallic zinc, actually proved that the zinc was deposited on the iron. The iron strip from the other couple gave no test for zinc. Upon exposure to the air, the former did not rust, while the latter soon showed its characteristic red oxide film.

*From a paper presented at annual convention of the National Association of Practical Refrigerating Engineers, Detroit, Mich.

†Technical Research Department, Dow Chemical Co.

Why Boiler Tubes Burnt Out

Removal of Scale Resulted in Tube Failure—A Scientific Study Made of Conditions—Trouble Due to Sulphur in Oil

By GEORGE C. REINHARD*

THE problem of tube failure when boilers are operating at high rating has attracted many investigators. It appears that any and all phenomena have been observed with the result that much irrelevant matter and information have been collected. The investigations and reasonings used have, in most cases, been far from scientific, and in many cases the

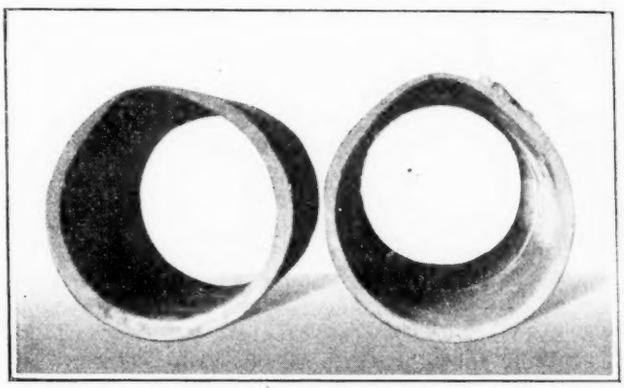


Fig. 1—Cross-section of tubes at point of failure, showing thinning of the metal

fault has been erroneously, and sometimes unfairly, laid to causes that could not in any way be responsible. It was just such a case that prompted the investigation conducted by the writer.

A large plant with oil-fired horizontal water tube boilers, although having no tube trouble, experienced considerable scale accumulation in the tubes. The scale at times attained a thickness of $\frac{1}{4}$ to $\frac{3}{8}$ in. and frequent, laborious and expensive turbining was practiced to keep these tubes in fairly clean and efficient condition. Consequently, it was decided to make an investigation of the underlying causes.

For a while everything went well, the tubes were eventually rid of all but an eggshell thickness of scale, when seemingly all at once, the trouble of tube burnout appeared. Investigations were conducted with no logical solution to the problem being arrived at, when finally the trouble was laid to the water treatment recently installed. The reasoning, apparently quite logical, was somewhat as follows: Without the water treatment and with scale the trouble was not experienced. Since the treatment was installed, scale has been eliminated, a factor that could not be responsible, and since all other conditions excepting the water treatment remain the same, this must be the cause.

The scale remaining in the tubes, if immediately removed upon opening the boilers, carried 50 per cent water. It was soft and sludgy, and it was generally agreed that this could not be responsible unless accompanied by poor circulation of the water in the boiler, and in this case the trouble would have been manifest before installing the treatment, when the scale was thicker and harder.

It was decided to trace the trouble to its source by means of a strictly scientific investigation, and with this in mind the investigation was begun.

A number of blistered tubes were sent to the laboratory. They were all from the lower row of tubes immediately over the oil jets, and all were very much the same in general appearance. A superficial examination proved conclusively that the trouble was caused externally and not internally as contended. Examination showed that burning or, rather, wasting occurred first, followed by the formation of a slight blister where the tube was weakened. If the blister had been caused by scale or deposit, it would have formed first, followed by burning of the iron. In this latter case the blister would have been evenly distributed instead of appearing localized where the tube was weakest.

These tubes carried a large, cone-shaped accumulation of iron oxide, two or three times the diameter of the blister. The blister appeared toward the center of this, and at the very center the fracture occurred. This

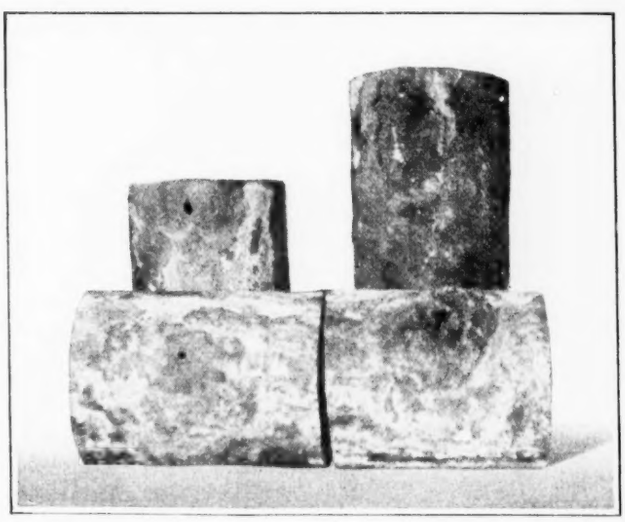


Fig. 2—View of under sides of defective tubes

fracture invariably appeared where the tube was reduced to a mere shell in thickness.

When the blister, caused by scale, appears and subsequently burns out, it is due to the fact that in blistering, the iron is separated from the scale by a steam cushion which acts as an insulator of the heat, and at all points where this insulation is present, the iron is overheated and in the oxygen of the draft the outer part is oxidized or burned out.

It follows then that in view of this reasoning, the

*Chief Chemist, Feedwaters, Inc.

conclusion mentioned is logical. Finally, the iron oxide had the appearance of a building-up action rather than an ordinary burning of the iron. Having satisfied ourselves that the cause was external and not internal, the investigation was continued by confining our examination to the exterior of the tubes.

Various theories presented themselves as to the possible cause, since in any scientific investigation a theory must be first formulated and this in turn accepted or

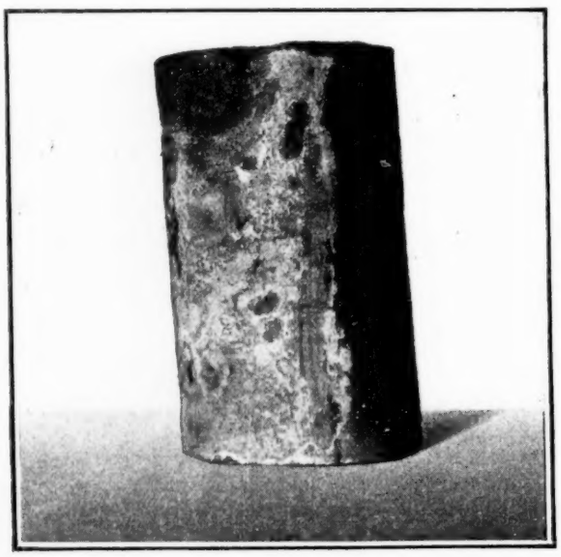


Fig. 3—The iron sulphates on this tube were removed with water; note sharp line where the fusion products were formed

rejected according to whether the evidence supports it or not. The theories entertained follow:

1. Soot deposit and accumulating oil prevented complete combustion and caused local superheating of the tubes.

2. Soot deposit caused local insulation, prevented even distribution of the heat and caused this to become sufficiently intense to cause a burnout.

3. Oil jets worked incorrectly, preventing atomization of oil and causing subsequent superheating of tubes.

4. Oil jets worked incorrectly, produced a blow-torch effect, which in turn caused overheating and burnout.

In following out Theories 1 and 2, portions of scaly matter were removed from around the burnout and examined to determine if this material was soot. A small amount of this was present, so the thought was still entertained that possibly this was a contributing factor. The fact, however, that the tube was clean internally, dispelled more or less the idea of superheating due to any cause, for with the water in direct contact with the tube superheating is an impossibility.

In studying Theories 3 and 4, the tubes were examined for grease with negative results. This is to be expected, since, at the high temperature of burnout, all oil would be volatilized. Investigation at the plant disclosed the fact that no change had been noticed in the operation and functioning of the nozzle tips. However, even if evidence of a blow-torch action had been discovered, it could not be reconciled as the cause of tube loss by burnout since the interior of the tubes was in such a clean, healthy condition.

A fifth theory, while not entertained at first, was advanced in the course of examination of the other theories.

When scraping the soot off the tubes, it was noticed that the deposit on the upper portion of the tubes was softer and thicker than that adhering to the bottom and sides. It was easily removed, was of a greenish color in appearance and possessed a peculiar moist feel. This aroused the suspicions of the investigator, who immediately took steps to determine the nature of this deposit.

Heating was the first test to which this material was subjected. This was done with the specific purpose of determining its action under the influence of heat, such as would be encountered on the tubes in the furnace. The material fused and left a deposit adhering to the metal spatula not unlike that found on the bottoms and sides of the burned out tubes. This deposit was identified in both cases as black oxide of iron. We were now striking parallel cases, duplicating what was taking place on the tubes under fire.

At this point the most logical theory took root in the nature of an idea that this soft, greenish deposit was accumulating on the tubes and under the heat of the fire was fusing and acting as a flux to cause corrosion and wasting of the tubes until they were reduced to a point where they could no longer resist the pressure in the boiler and they blistered and blew out. Further examination showed this deposit to be composed entirely of ferrous sulphate ($FeSO_4$) and ferric sulphate ($Fe_2SO_4)_3$, was soluble in water, resulting in an acid solution, and this solution was high in both iron and sulphate content.

Again reverting to an examination of the tubes themselves, it was revealed that a definite line was present, separating the soft, unfused material from the hard, fused material. When the boiler was in operation, the ferric and ferrous sulphates formed on the outer portions of the tubes, fusing under the influence of the high temperature. When in the liquid state they gravitated to the under portion of the tube, where they became more and more concentrated and attacked the iron much as a flux and gradually weakened the tube to such an extent as to cause blistering and blowout.

It is relatively simple to explain the origin of the iron sulphates. All fuel oil, especially of a poor quality, contains sulphur. In burning, this sulphur forms sulphur dioxide as follows:

$$S + 2O = SO_2$$

all oil, owing to its organic nature, forms water when burned, and this water combines with the sulphur dioxide above to form sulphurous acid, the reaction being

Water + Sulphur Dioxide = Sulphurous Acid

$$H_2O + SO_2 = H_2SO_3$$

In the presence of the oxygen from the draft, this oxidizes the sulphuric acid as follows:

Sulphurous Acid + Oxygen = Sulphuric Acid

$$H_2SO_3 + O = H_2SO_4$$

Now this sulphuric acid attacks the iron of the tube in varying proportions to form both ferric and ferrous sulphates, the reactions being:

Sulphuric Acid + Iron = Ferrous Sulphate + Hydrogen

$$H_2SO_4 + Fe = FeSO_4 + 2H$$

and

Sulphuric Acid + Iron = Ferric Sulphate + Hydrogen

$$3H_2SO_4 + 2Fe = Fe_2(SO_4)_3 + 6H$$

The conclusions drawn from the investigation were that corrosion was due to an external cause; that external superheating could not be responsible in view of

the interior condition of the tubes; that oil jets were not responsible; the cause of blistering and blowout was due to a corrosive action caused by the combustion and oxidation of the sulphur to sulphuric acid, which corrosion, in conjunction with fusion of the products of corrosion, so weakened the tubes as to cause them to blister and blow; the cause was traced directly to the oil, which, owing to its sulphur content, was the basic cause of the evil.

Realizing that one should not only trace the cause to its source, but also advance possible remedies, the following recommendations are offered:

The first and most positive recommendation made is the reduction of the sulphur in the oil. Its entire elimination is desirable, for in this way the prevention of the evil action will be most assured.

It is possible that by incorporating in the oil some material, which, at the high temperature of combustion in the furnace, is capable of rendering the sulphur products inocuous, the evil can be prevented.

Tubes should receive the same care externally that they do internally. Frequent cleaning externally is recommended, to remove the deposits of ferric and ferrous sulphates before they attain sufficient thickness to fuse and flow. In this way the lives of the tubes will be materially lengthened.

Minimizing Oxidation

Excessive oxidation of the sulphur should be avoided. Of the combustible materials in oil this has the least affinity for oxygen. Possibly by regulating the draft by some ingenious device, combustion of this can be prevented or the oxidation of the sulphurous acid to sulphuric acid can be prevented. Effecting either will eliminate the evil.

Since the greatest accumulation and condensation of sulphuric acid occurs when the tubes are still cold, that is, immediately after starting, it is suggested that to keep this condensation at a minimum, the boilers be filled with preheated water, as close to 212 deg. F. as is possible to obtain, and as soon as the water is brought to a boil the tubes be cleaned of external deposit of iron sulphate by cleaning with compressed air.

Coating the tubes with a highly conductive, non-corrosive material should eliminate the evil without impairing the efficiency of the boiler. The manufacture of boiler tubes of non-corrosive steel such as chrome steel or similar alloy is suggested, as this should prove a very effective way of thwarting the action of the sulphuric acid.

Now with the evidence referred to and illustrated how it supports the theory, the following objections are raised and explained for a similar purpose.

First of all the question is asked, Why is it, if the foregoing theory is correct, that the trouble is not manifest and encountered in coal burners when it is known that coal also carries a fair amount of sulphur, the basic cause? On the face of it this refutes absolutely the main contention, namely, that sulphur is primarily responsible for the trouble.

By careful analysis of conditions prevailing in the combustion of coal and oil, important differences are noted, and these differences are sufficient to allow the action to proceed in one case and not in the other.

Firstly, sulphur is not present in coal in such large amounts as is found in oil; if, however, it were present to the same extent, the main difference between coal and oil must be considered.

Oil is almost entirely organic in nature, coal quite the contrary. The organic matter carries a large amount of hydrogen which, when burned, forms water. This water must be present, even though it be there as steam, before the sulphur products can form sulphuric acid.

Coal is mainly inorganic in its composition, and being more deficient than oil in both its sulphur and hydrogen content, this trouble will rarely occur in coal burners.

Another objection is: Explain then why, when the tubes carried scale, this trouble was not met. Only when the tubes were free of scale was the trouble manifest.

Clean Tubes Corrode Quickly

Contrary as it may seem, the cleaner the tubes the more rapid will be the corrosion and blowing of tubes. With the tube clean internally, the water is in direct contact with the tube and is constantly conducting the heat from it. In other words, immediately outside of the tube the temperature is only slightly higher than the temperature of the water inside, even though the tube is in an intense heat. It is this very fact that prevents the tube from burning. This low temperature is sufficiently low to condense the sulphuric acid being formed, and the acid so condensed, begins to attack the iron to form the sulphates of iron. When this deposit attains sufficient thickness, it fuses and this hastens the corrosion.

Where scale is present in the tube, the possibility of this action going on is considerably reduced, for the scale, in preventing the conduction of the heat from the tube, allows it to become heated above the condensation temperature of the sulphuric acid, and for this reason it passes out of the flue without working any evil.

An investigation is being conducted at the Pittsburgh, Pa., experiment station of the Bureau of Mines, Department of Commerce, to determine whether the character of the precipitates forming in boilers may be made to assume a form in which they do not attach themselves to the walls; and if the material in the boiler wall exercises any influence. Data have been obtained on the noncondensible gases which are carried off in the steam, and the correct relationships to be maintained when carbonate becomes unstable and phosphate must be used in boiler-water conditioning. The use of phosphate may form objectionable deposits. This condition is being looked into. Further, indicators used in titrating boiler waters do not necessarily represent the true phosphate or carbonate concentration. Means of controlling this indication are being investigated. Conditions that may bear on wet steam are being watched in the hope that definite information may be acquired on the factors influential in wet-steam development and thereby control be obtained over them.

The metric system was legalized in the United States by act of Congress in 1866. The customary English units were defined in terms of the metric unit. Fundamentally, we have in the United States no standard yard, standard pound, or other standard English unit. We do have a standard meter and kilogram. The inch is defined as 1/39.37 of the standard meter. The pound is defined as a unit of such size that 2.204622 lb. will equal the standard kilogram. These metric standards are deposited in the Bureau of Weights and Measures.

Governing a Large Reheating Turbine

THE Crawford Avenue Station of the Commonwealth Edison Company of Chicago, described in *Power* for June 16, 1925, operates on the reheating cycle, steam being taken from the discharge of the high-pressure turbine to the boiler room, where it is re-superheated before it enters the lower-pressure turbines.

This scheme introduces difficulties in governing, because of the large mass of steam stored between the high-pressure governor valve and the entrance to the low-pressure turbine. Should the unit lose load and overspeed, the simple closing of the main governor valve would not save the turbine from disaster, since the mass of steam stored inside that valve at a pressure of 100 lb. per sq.in. or more, is sufficient by its own expansion to speed the low-pressure turbine to destruction. Accordingly, the governor system of a turbine of this type must be more complicated than that of a simple Rankine-cycle turbine. The diagram of Fig. 1 shows the governor layout for the Westinghouse machine at Crawford Avenue.

The entire mechanism is shown in the full-load position, with the governor valve open and the governor sleeve in its lowest position. Upward movement of the governor sleeve (shown at the right of the figure), which results from increasing speed, first closes the governor valve and, if the movement continues, opens the bypass valve shown at the left of the figure and closes the butterfly valve. The bypass valve passes the steam returning from the reheaters directly to the condenser of the low-pressure turbine, and the butterfly valve prevents this steam entering the intermediate-pressure turbine. Thus the steam stored in the piping system is prevented from tending to overspeed the machine.

Overspeeding of either the high-pressure or the low-pressure rotor trips the corresponding emergency governor, both of which are shown at the right of the figure, and these through the oil-relay mechanism trip the main throttle valve, open the bypass and close the butterfly valve.

Elastic links in the mechanism for the bypass valve and the governor valve, shown in the upper left-hand portion of the figure, are necessary because the butterfly valve must close as soon as the governor valve begins to open and must remain in this position throughout the travel of the governor valve. On the other hand, when the governor valve closes, the butterfly valve must immediately open through its entire range of motion. Study of the mechanism will show the necessity of these elastic links and the manner in which they operate.

The governor-valve elastic link is shown without extension or compression and stands in that position for all operating loads. With no oil pressure and with the governor in the innermost position the link compresses 3¾ in. with a total spring load of 115 lb. With the bypass valve wide open the link extends 2¾ in. with a total spring load of 150 lb. The bypass-valve elastic

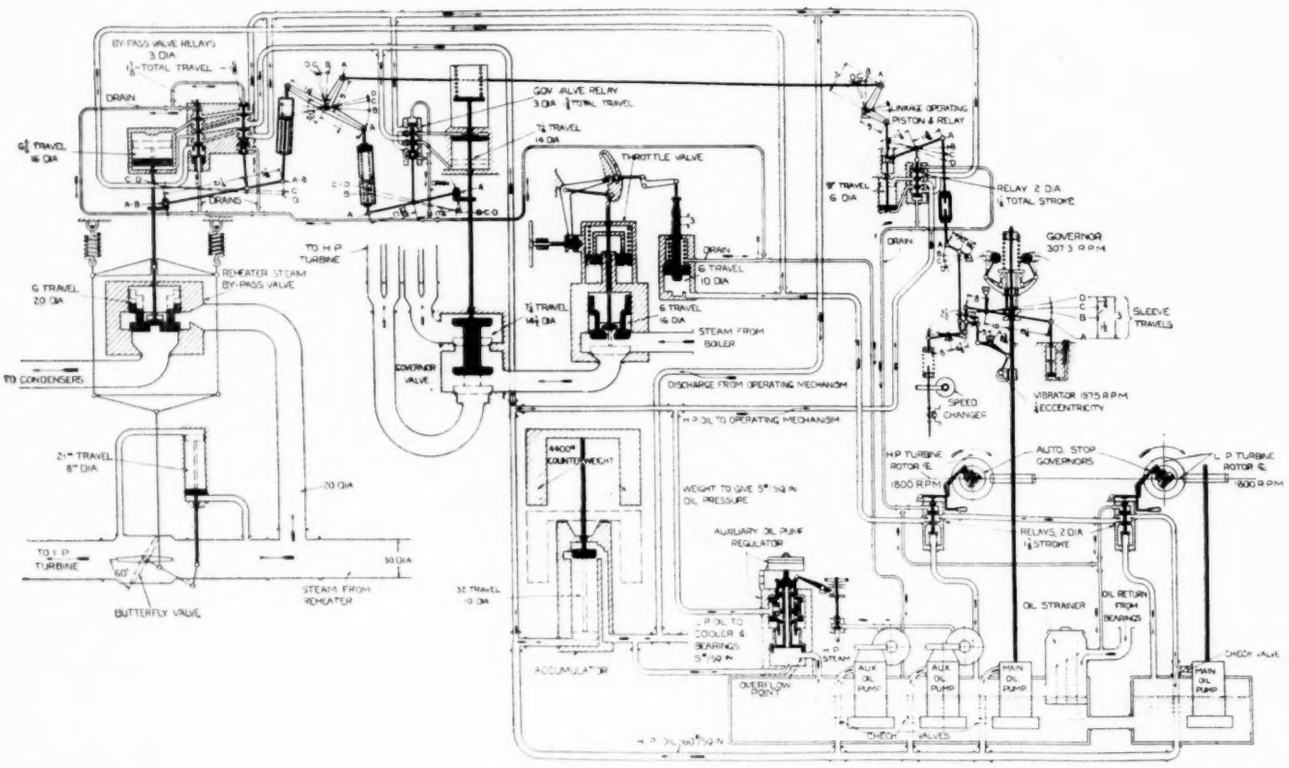


Fig. 1—Governor at right, through the oil relay shown above it, operates the governor valve and reheated steam bypass and butterfly valves, through their combined relay mechanism, shown at the left

A shows governor at low-speed or full-load position with main valve open, bypass closed and butterfly valve wide open. *B* is mid-position at low load with governor valve closed, bypass closed and butterfly open, admitting steam to intermediate-pressure turbine only. *C* indicates three-quarter position of governor sleeve, governor valve closed, reheater bypass open and butterfly closed, shutting steam off from all turbine elements. *D* corresponds to the same condition as position *C*, but with an allowance of additional governor travel for the purpose of compensating for wear and for any incorrect adjustment.

link, with the governor valve wide open, extends as shown, with a total spring load of 195 lb. With no oil pressure and with the governor in the innermost position this link extends 8¼ in. with a total spring load of 206 lb. With the bypass valve wide open the link is without extension and the spring load is 125 lb.

To provide sufficient power for the operation of the entire mechanism, including the elastic link devices, an oil-pressure relay is installed, shown just above and to the left of the main governor mechanism in the upper right-hand portion of the figure. In order to supply the heavy momentary demand for high-pressure oil, an accumulator has been included, as shown in the lower central portion of the figure. The capacity of this accumulator is sufficient for one complete operating cycle of the governor, even though the oil pumps were inoperative.

Attention is directed to the vibrator driven from the main governor shaft, by means of which the entire mechanism is kept in motion through a small amplitude for the purpose of eliminating static friction. This vibrator, with one-quarter inch eccentricity, operates at the rate of 197.5 r.p.m.

It is interesting to notice the way in which the auxiliary oil-pump regulator operates. When the accumulator on the high-pressure oil system, in which the pressure is some 55 lb. per sq.in., is at the top of its stroke, oil leaks out between the top edge of the accumulator cylinder and the bottom edge of the piston. This oil passes through the low-pressure oiling system to the bearings and the oil cooler. A branch connects to the auxiliary oil-pump regulator, which operates to maintain this pressure at 5 lb. per sq.in. If the pressure falls below this, the steam-driven auxiliary oil pumps are automatically started. The overflow pressure will fall below 5 lb. per sq.in. only when the accumulator is below the top of its stroke. This control scheme, therefore, operates the auxiliary oil pumps whenever the main accumulator is below the top of its stroke, and acts to keep the high-pressure system, including the accumulator, filled with oil at high pressure in constant readiness for the operation of the entire governor mechanism through a complete cycle. This is obviously essential to good governing.

Providing For Breakdown Service

By G. Grow

THE problems encountered by the engineer of an office building, hospital or public institution are by no means identical with those confronting the factory engineer. The necessity of insuring the continuity of service exists in the latter case, but if a shutdown does occur the loss rests on the factory alone. In the office building a discontinuance of power shuts down lights and elevators, inconveniencing every tenant. As a consequence a secondary source of power is imperative. Where the power is to be obtained at best advantage is not always so easily determined.

It is quite the current practice to obtain break-down service from the public utility. This in many localities works out as the most economical and dependable arrangement. In other instances this auxiliary power has been obtained by a form of interconnection between two buildings or factories on the well-grounded assumption that seldom, if ever, will the two power plants have trouble at the same time.

A third method deserving attention is the use of gasoline- or oil-engine stand-by units. High-speed gasoline engines running at speeds up to 1,200 r.p.m. and oil engines of 600 r.p.m. have been on the market long enough to prove their dependability. Direct connected to alternating- and direct-current generators, either of these two engine types has been installed for emergency service. In fact one large company with buildings in every city in this country, makes use of such emergency units, although using central-station service for ordinary purposes.

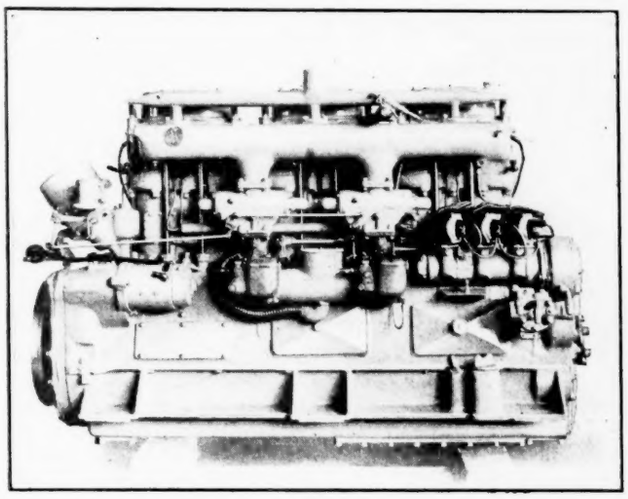


Fig. 1—High-speed type of gasoline engine

Compared to the running of duplicate lines in case of purchased current or the installation of breakdown electric service when power is generated in the building, the gasoline-engine auxiliary units will in many instances prove to be the cheapest.

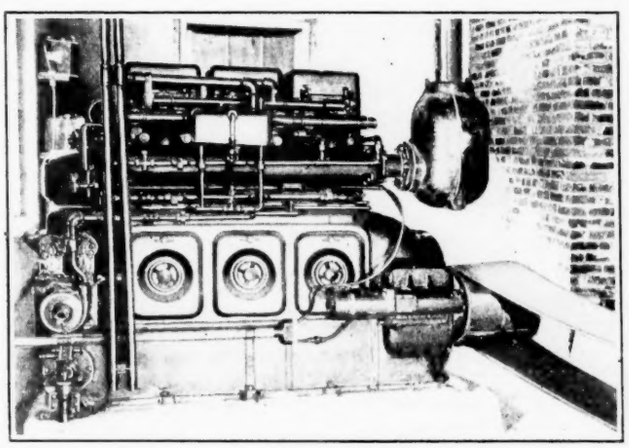


Fig. 2—Gasoline engine used as stand-by

For example, in one office building the generating units total 1,000 kw. Recently, some trouble occurred, leading to a shutdown of part of the building service. The occurrence was most unusual and will probably never occur again. Still, in the desire to guarantee at least elevator service at all times, the chief engineer decided to install a breakdown connection with the pub-

lic-service corporation. This service is for 300-kw. capacity, and the building must use 160,000 kw.-hr. of purchased energy during a year to obtain the connection. A sliding scale of prices is in effect, ranging from 5 to 4c. per kw.-hr. Using 4½c. as the average, the cost of the connection is $7,200 a year.

Undoubtedly, this minimum amount of power will be used during the summer or non-heating season, but as it is necessary to keep the engine- and boiler-room force the chief reduction in the plant's operating costs will be the cost of the coal saved. The fuel consumption in summer is 5 lb. per kw.-hr., the cost per ton being $4.50; this makes the fuel cost 1.12c. per kw.-hr. While using the 160,000 kw.-hr. of purchased current the coal saving will be $1,792. The yearly net cost of the breakdown connection is then $5,408.

Two 150-kw. gasoline engines direct connected to generators can be installed for less than $10,000. This investment would give a return of over 50 per cent a year. If interest, depreciation and taxes of 15 per cent be charged against the units, the net yearly saving over the electric connection becomes $3,908, equivalent to a profit of 39 per cent on the investment.

By reason of the small amount of time the engines will be run, cheaper engines, costing around $10 to $12 per horsepower, might be installed. The high- or medium-speed oil engine operating at around 600 r.p.m. is a late development and, being of a more sturdy design, will weigh from 50 to 75 lb. per brake horsepower. The cost of two 150-kw. units will be in the neighborhood of $18,000 including the generators. The overhead charges at 10 per cent would amount to $1,800. If the engines were used only for breakdown service, the

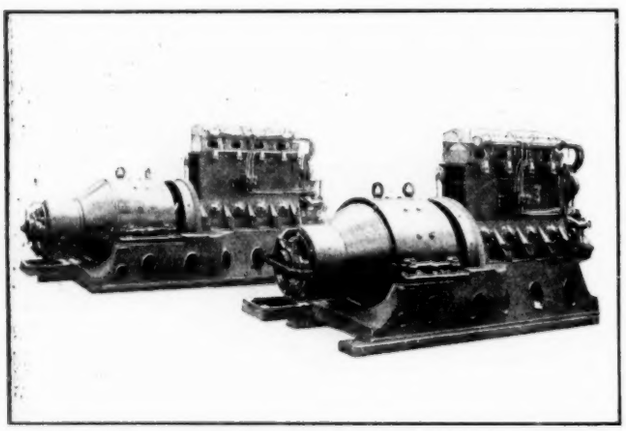


Fig. 3—Oil engines, weighing 12 lb. per hp. suitable for breakdown service

saving over the utility connection would be $3,608, or the units would be paid for by the savings in five years, overhead being the only charges.

However, there is no reason why the engines should not be run to the full capacity during the summer season. The fuel and lubricating oil consumption per kilowatt-hour should not exceed 5½ mills. Turning out 300 kw. for 20 hours daily the saving in cost over using all steam would be 0.5c. a kw.-hr., or $30 a day. This for the five non-heating months would result in a yearly saving of approximately $4,500. Under these conditions the saving by using auxiliary oil engines would be the sum of the saving in avoiding breakdown service, this being $3,608, and the operating saving during the summer of $5,124, a total of $8,732. This is an excess return on the investment of 45 per cent.

Every plant should have enough extra boiler capacity to permit shut-downs for furnace repairs, tube removals, etc. In the plant in question an extra 2,500-sq.ft. water-tube boiler, including stokers, trucking, etc., would cost at least $12,000. By the use of the auxiliary

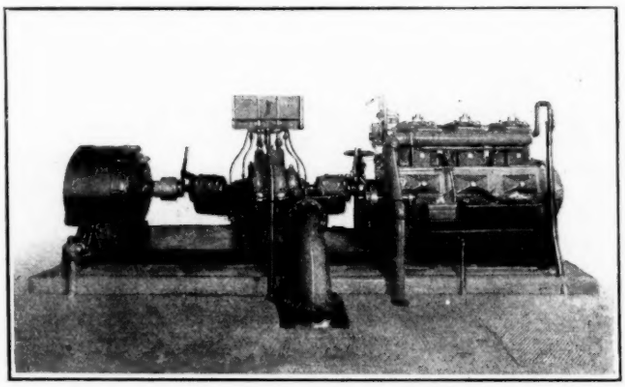


Fig. 4—Gasoline engine and motor connected to a single pump, insuring power at all times

oil engines an extra boiler need not be purchased. This reduces the net investment in the engine sets to $6,000, and as shown, as a pure breakdown installation this would be paid for by the savings in less than 1½ years. With summer operating the saving would amount to $9,732 a year.

As a means of reducing fire-insurance charges auxiliary sets are often installed in factories and in town pumping plants. When power is purchased, insurance rates may be substantially reduced by the installation of a gasoline-engine pumping unit. In the case of municipalities the reduction in the yearly premiums is often equal to one-half the cost of the breakdown units.

Failures Due to Dished Heads

Dished boiler ends have of late been the cause of serious explosions abroad. The boiler inspection associations on the Continent have attained practically all the powers and duties of government officials, and as explosions are investigated by their chief engineers, who in a sense are themselves responsible for the safety of their boilers, much interesting information is withheld. Thus in nearly all these cases the inspectors had not reported any cracks before the explosions occurred, yet after these occurrences adjoining boilers were found to be cracked. In fact, in one country quite an epidemic set in with respect to the renewals of dished ends of boilers, and also quite a number of experiments were made on this very interesting subject. Thus Professor Bach carried out 16 tests on dished ends, and isolated tests were made at various boiler works.

The object with which some of these tests were made was to demonstrate that, as might be expected, dished ends of elliptical outline, the two semi-diameters being in the ratio of 1 to 2, were stronger than the ordinary dished ends with radii of curvature equal to their diameters. The elliptically dished ends were found to be more than twice as strong as the ordinary ones, at least under the conditions of hydraulic testing. Whether the disproportion will be equally great as to the fatigue stresses met with in boilers remains to be seen.—*The Manchester Steam Users' Association Report.*

Recooling Oil-Engine Jacket Water

By Edgar J. Kates*

IN MANY oil-engine plants the high cost of water makes it desirable to save and re-use the warm water discharged from the cooling jackets of the engine. For instance, a 200-hp. engine on the customary basis of 8 gal. of cooling water per brake horsepower, will require 1,600 gal. of water per hour. If water costs 25c. per 1,000 gal., the cost of the jacket water for this engine would be 40c. per hour, or, for 300 days of 10 hours each the cost would be $1,200, an amount well worth saving.

The simplest method of cooling the water so that it may be re-used in the engine is to expose it to the air either in cooling towers, cooling ponds or sprays. These methods of cooling are called "open cooling systems," and a typical arrangement is shown in the

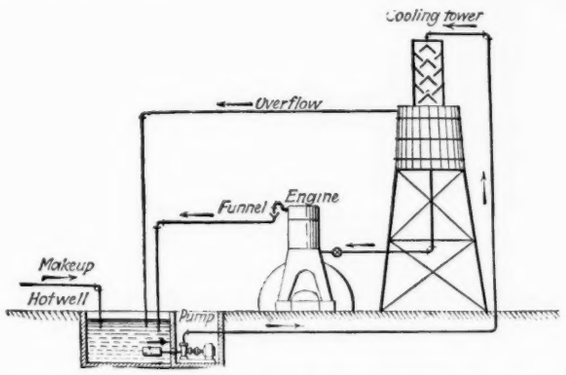


Diagram of an objectionable cooling-water system

illustration, in which a cooling tower is shown. In this arrangement an overhead tank is used and an open outlet in the water discharge line from the engine.

As shown, the engine receives its water by gravity from the overhead tank and discharges it into a hotwell; a pump picks it up from the hot well and delivers it to the top of the cooling tower, through which it drops and is cooled, and then falls into the overhead tank to repeat the circuit. The circulating pump is of course made larger than the maximum engine demand, and an overflow pipe is therefore provided in the overhead tank to permit the excess to return to the hotwell.

How Cooling Towers Are Made

Cooling towers may be made of metal troughs, wood slats or wire screens, in fact, anything that will expose the water in thin films to the air. Cooling sprays cool by dividing the water into small drops, thus increasing the surface exposed to the air. In all cases the cooling effect is accomplished mostly by evaporating part of the water and thus cooling the remainder. The amount of heat that a pound of water absorbs when it evaporates at, say, 140 deg. F.—in other words, the latent heat—is 1,015. Most of this heat will be taken from the surrounding water. Therefore, it is possible, roughly speaking, to cool 25 lb. of water 40 deg. F. by evaporating only 1 lb. While it is true that some of the heat of the water is delivered directly to the air, thus cooling the water by heating the air, nevertheless the quantity of heat thus transferred by convection is quite small in comparison with the amount absorbed through evaporating part of the water.

In the engine used as an example, 1,300 gal. of water per hour is continually circulated and the temperature rise in the jackets is about 40 deg. Since the evaporation of one pound of water will cool 25 lb. 40 deg., to cool the jacket water of this engine will require the evaporation of about 65 gal. of water per hour. Assuming the same price for water as before, the cost of the lost water will be 1.6c. per hour, or about $50 per year.

So far, so good. We have cut the cost of jacket water for this engine from $1,200 a year down to $50, and the expense is merely the cost of a small addition to the pumping power and the maintenance of the cooling tower or sprays.

But the open cooling system has one serious defect when the water is hard, that is, when it contains scale-forming minerals in solution. The cooling, as has already been noted, is accomplished by evaporation. Of course only pure water evaporates and the dissolved minerals are left behind in the remaining water, which thus becomes more concentrated with them.

Concentration of Mineral Salts Through Evaporation

The rapid concentration of mineral salts through evaporation is so insidious that it is sometimes doubted. Nature, however, presents a striking example in the Dead Sea in Asia Minor. This body of water is about 1,300 ft. below sea level and has no outlet. It is about 50 miles long and 10 miles wide. Although the River Jordan carries into it about six million tons of water daily, the evaporation in that hot climate is so great that it disposes of this quantity of water and the level of the basin remains unchanged. This continuous evaporation has caused the water of the Dead Sea to become more and more surcharged with the minerals carried into it by the makeup of the River Jordan, so that now the solids in solution make up one-quarter of the entire weight of the water. The extent of this concentration may be judged by the fact that ocean water contains only about one-twentieth of its weight in dissolved solids.

The evil results of concentration in jacket water is shown by the following example: For the same 200-hp. engine assume the amount of water in the jacket-water system to be 2,000 gal. and that this water originally contains 3 grains per gallon of calcium and magnesium carbonates, that is, 3 grains per gallon of "temporary hardness," making a total of 6,000 grains. The cooling tower evaporates 65 gal. per hour, which results in the capacity of the entire system being evaporated in about 30 hours. This loss of water is of course compensated during this period by adding 2,000 gal. of makeup, thus introducing 6,000 grains more of carbonates and increasing the concentration to 12,000 grains in 2,000 gal., or 6 grains per gallon. Every 30 hours of operation the mineral content increases three grains per gal., and it is only a comparatively short time before the concentration is so high that when the water is heated in the engine jackets, it is unable to retain all the mineral matter in solution, whereupon scale is deposited on the jacket walls. The harmful effects of such scale, such as cracked cylinder heads, seized pistons, etc., are well known, and every means possible should be taken to avoid scale formation.

*Chief engineer, De La Vergne Machine Co., New York City.

The Installation and Uses of Conduit

By J. Elmer Housley

THERE are several kinds and types of conduit, and these may be roughly divided into rigid and flexible. In the former classification appears the rigid-iron and rigid-aluminum conduit and fiber duct. The flexible division includes flexible metal conduit and woven duct or circular loom. Sometimes the wires are incorporated within the flexible conduit and become armored cables, such as the well-known "BX" and "BXL," the latter having a lead sheath for moisture proofing.

The use of conduit developed from the need of protection for buildings and materials against short-circuits and grounds which might occur. Wires run in the open may become damaged, therefore the complete mechanical protection for the circuits is evident and its desirability is widely recognized. In certain types of building construction the electric services cannot be accommodated except in conduit.

The rigid-iron conduit finds the widest general application, due to its moderate cost and likeness to iron pipe as a construction material. Iron conduit is furnished in 10-ft. lengths in sizes of ½ in. to 6 in. diameter and is enameled inside and outside for the black type, the other type being plain galvanized finish on the outside. Iron conduit is durable where not exposed to moisture or corroding influences. The weakest point is where the threads are cut, and the conduit usually fails at this point first, under unfavorable conditions. The exposed threads should be painted in all cases, also care should be taken to prevent the enamel being torn off by wrenches during installation.

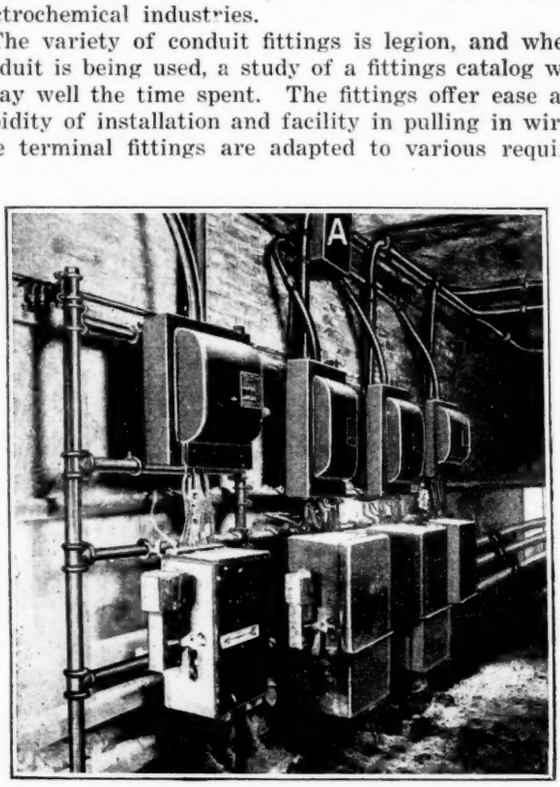
Rigid-aluminum conduit was introduced commercially under the underwriters' label during 1922. It corresponds to iron conduit as to dimensions. This conduit has about one-third the weight of iron, which makes it valuable for use on traction and railway equipment due to the reduction of weight. In general the chief value of aluminum conduit is its resistance to corrosion because of a protecting film of oxide which forms on the metal. The metal comes from the die smooth and requires no paint for protection, and a smooth runway is provided for the wires. Moisture and dilute sulphuric acid water and vapor such as found about ash-handling equipment, coal mines and railway roundhouses has no corroding influence on aluminum conduit. The one possible corroding agent is caustic solutions.

The fiber duct is a molded fiber product and cannot be bent or formed on the job. The elbows are made with a long radius and the joints are usually of a slip type. This material is most often used in power houses and is embedded in concrete to provide a runway for large cables. Such a non-metallic material must be used where alternating-current cables are run singly in separate conduits, otherwise the magnetic field surrounding the single wire would cause a heavy induced current in the conduit and in some cases it might become red hot. Where all phases are in the same conduit, the magnetic fields neutralize each other. It is generally the rule to run large direct-current leads in separate metallic conduits because of the economy and ease of installation of the smaller conduits.

Where conduit passes under a floor in the form of a "U," trouble often results from condensation of moisture and sometimes leakage of water into the conduit. Rubber-covered wire does not last long under such conditions, and sometimes lead-covered cables must be used in the conduit. Where the conduit is exposed to high temperatures flameproof wire should be run open.

Metallic conduits should not be run underground between points where electroltyic action may take place, such as around traction power houses and in many electrochemical industries.

The variety of conduit fittings is legion, and where conduit is being used, a study of a fittings catalog will repay well the time spent. The fittings offer ease and rapidity of installation and facility in pulling in wires. The terminal fittings are adapted to various requirements for the protection of the exit wire and conduit against weather, water and dirt. Conduit fittings are ordinarily made of cast iron and enameled. Many overlook the fact that most makers are prepared to furnish the same fittings made of aluminum or brass, and these may profitably be used where local conditions indicate the necessity.



Safe conduit installation in wet basement

Conduit is run on ceiling. Junction box *A* is arranged to permit removal of any switch without interrupting service to other drives.

Conduit is usually fastened to the steelwork of the building without the drilling of steelwork by means of clamps. A common method is the use of the universal knob support with a ring strap around the conduit and secured to the knob support by a ¾-in. or larger cap-screw. Where the conduit crosses a steel member at right angles, two knob supports are used with a pipe strap or flat strap across the conduit between the knob supports. These fittings come in various sizes and a size large enough to give ample strength should be used, depending on the size of conduit and the frequency of supporting points, which should not be at greater distances than five feet apart.

The installation of conduit offers limitless opportunity for the display of ingenuity in devising methods of attaching it to steel, concrete, brick and wood, and at the same time make a neat and permanent job. The use of wood plugs should not be condoned where brick or concrete walls are drilled to allow attachment of lag

or other screws. Metal expansion shields should be used to secure a safe and permanent job.

Referring again to the placing of conduit where moisture or dirt is present, the conduit should be run along the ceiling or roof and down walls or columns to motors, control apparatus, etc. This method largely eliminates troubles from condensation, the shifting of the floor arrangement of machinery and difficulty in making changes in circuits buried in a concrete or other type floor. In new construction the building operations are not hampered or delayed by a great network of conduit which must be formed and assembled and protected against the entrance of concrete. In every plant the conduit methods and plan must be adapted to the particular conditions that exist, as to the possibility of trouble due to nature of materials handled, the probability of expansion of service with increased load and the necessity of future rearrangement of process routing or location of equipment.

Fatigue of Metal Investigation Extended to High Temperature

One of the most important engineering studies now in progress is the investigation of the fatigue of metal conducted by the Engineering Experiment Station of the University of Illinois in co-operation with the National Research Council, Engineering Foundation, General Electric Co., Allis-Chalmers Manufacturing Co., Copper & Brass Research Association and Western Electric Co. The work has been going on for several years and has produced much valuable practical information on the fatigue of metals. Progress has been reported from time to time in *Power*.

The extension of this study to high temperatures is already yielding results that will be of value to designers of engines, turbines, piping, valves and other power-plant apparatus. The apparatus, methods, data and conclusions are discussed in bulletin No. 152, recently issued by the Engineering Experiment Station. Apparatus has been devised whereby a specimen may be spun with continuous reversal of stress within a space heated to any desired temperature by electric coils, the actual temperature being measured by thermocouples.

Shaft Diagrams

By J. R. Hurford

VARIOUS formulas have been used in the design of shafts subject to a combination of twisting and bending. Perhaps the most trustworthy are those developed by A. Lewis Jenkins in a paper presented at the 1917 annual meeting of the A.S.M.E. Readers interested in a mathematical study of the problem and comparison of various formulas are referred to Mr. Jenkins' paper, which may be found in the 1917 "Transactions" of the A.S.M.E.

Mr. Jenkins advises the use of the following formula for a shaft made of ductile material, such as soft steel for example:

$$D = \sqrt[3]{\frac{6.620}{S_s}\sqrt{M^2 + T^2}}$$

In this formula

D = Diameter of shaft, inches;

S_s = Equivalent shearing stress, lb. per sq.in.;

M = Bending moment, pound-inches;

T = Torque, pound-inches.

The formula was developed rationally from the "maximum-strain" theory, using a value of 0.25 for Poisson's ratio.

To solve this formula graphically, the writer has constructed accompanying charts *A* and *B*. Chart *A* is for shafts ranging from 6½ to 13 in., while shaft *B* covers diameters from 13 to 24 in.

The method of use is illustrated by two examples on each chart. To combine range with accuracy, there are two sets of figures for *M*, *T* and *D*. One set is in parentheses and the other is not. It is only neces-

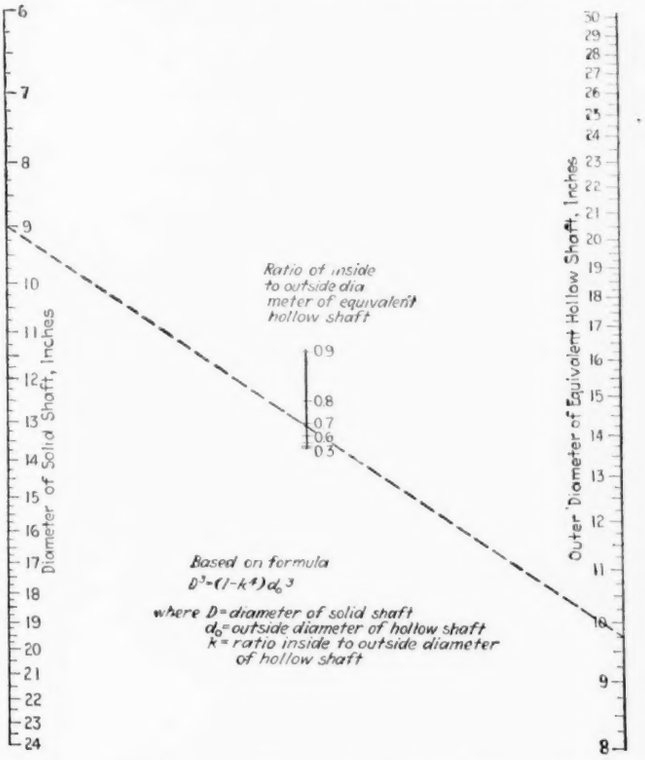

Diameter of Solid Shaft, Inches
Outer Diameter of Equivalent Hollow Shaft, Inches
Ratio of inside to outside diameter of equivalent hollow shaft
0.9
0.8
0.7
0.6
0.5
Based on formula
$D^3=(1-k^4)d_o^3$
where D = diameter of solid shaft
d_o = outside diameter of hollow shaft
k = ratio inside to outside diameter of hollow shaft

Fig. 1—Chart giving proportions of hollow shaft equivalent to a given solid shaft

sary to remember that these three quantities must all be read on scales in parenthesis or all on scales not in parenthesis.

The more common problem is to find the diameter of a shaft for a given equivalent shearing stress with a given bending moment and torque. This is illustrated by Example I on both charts. Example II, where the stress is to be found for a given shaft subjected to given bending moment and torque, involves a cut-and-try solution.

Here the line passing through the diameter on the central scale is rotated until it gives the same shearing stress in both sections of the diagram. A study of the lines in Example II will make the procedure clear.

Where a hollow shaft is to be used, Fig. 1 makes it easy to determine the internal and external diameters of a hollow shaft equivalent to a solid shaft of given diameter. The solution indicated by dotted line shows that a 9-in. solid shaft is equivalent to a hollow shaft of 9¾ in. outside diameter and having an inside diameter 0.7 of the outside diameter.

Charts Relating Shaft Diameter, Equivalent Shea

Diagram A for 6½ to 13 in. Shafts
Based on formula $D=\sqrt[3]{\frac{16.62}{S_s}\sqrt{M^2+T^2}}$
Where D = Shaft diameter, inches
S_s = Equivalent shearing stress, lb. per sq. in.
M = Bending moment, lb. in.
T = Torque, lb. in.
Diameter, inches
Torque, Thousands of Pound-Inches
Bending Moment, Thousands of Pound-Inches
Shearing stress, thousands of pounds per square inch
Example I
Example II
Given M=828,000, T=910,000, S_s=10,000
D is found to be 9-11/32 in.
Given D=11, M=2,025,000, T=1,920,000
S_s is found by trial to be 13,900
First trial, marked A, gives two different values for S_s—Final trial marked B, gives same value of S_s on left and right
Designed by J.R. Hurford

Shearing Stress, Bending Moment and Torque

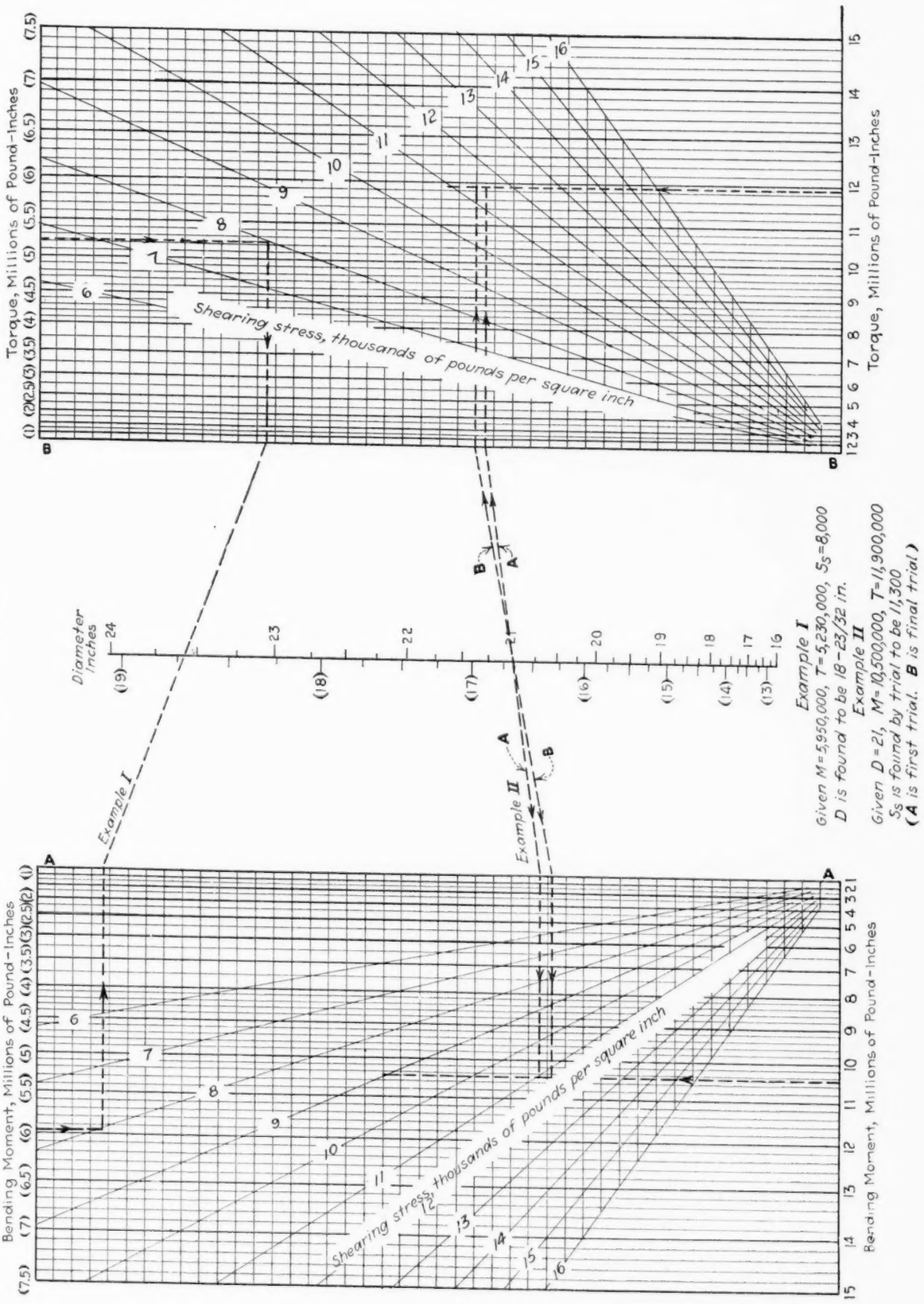

Torque, Millions of Pound-Inches
Shearing stress, thousands of pounds per square inch
Bending Moment, Millions of Pound-Inches
Diameter Inches
Example I
Example II
Example I
Given M=5,950,000, T=5,230,000, Ss=8,000
D is found to be 18-23/32 in.
Example II
Given D=21, M=10,500,000, T=11,900,000
Ss is found by trial to be 11,300
(A is first trial. B is final trial)
Designed by J. R. Hurford

Diagram B for 13 to 24 in. Shafts

(Same formula as diagram A)

Stop-Check and Safety-Valve Group at the Holtwood Station

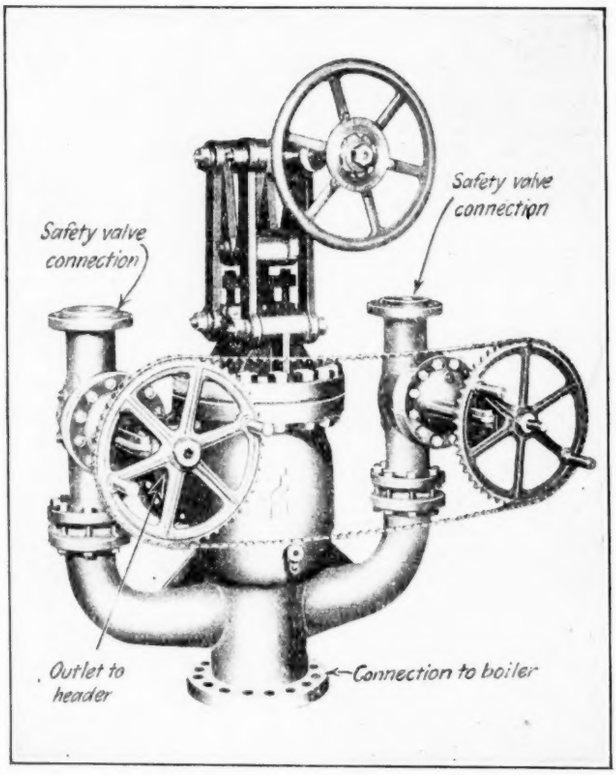
The adoption of high steam pressures and superheat in power plants and particularly the larger central stations has made necessary some radical changes in valves, piping and other auxiliary equipment.

In the later and more modern plants it has become general practice to eliminate fittings in the high-pressure steam lines wherever possible. This is accomplished by the use of welded nozzles on the pipes. With the elimination of the fittings and consequently a large number of flanged joints, one of the chief sources of trouble, that of maintaining tight joints, has been materially lessened.

In designing the Holtwood steam station of the Pennsylvania Water & Power Co., the engineers endeavored to eliminate as many joints as possible not only on the high-pressure piping system, but also in the connections to the boiler and superheater. As the boilers were to operate at 400 lb. pressure and the steam would have a total temperature around 700 deg., it was considered advisable to locate the superheater safety valves so that they would be readily accessible for overhauling without cutting the boilers out of service.

As one 4-in. safety valve gave sufficient capacity to meet the requirement of the Boiler Code, the power company's engineers in co-operation with the designing engineers of the Schutte & Koerting Co., developed the stop-check and safety-valve connection shown in the illustration.

Two 4-in. safety valves are carried on elbow outlets cast integral with the body of the main stop-check valve, each connection having a gate valve directly below the safety valve. To meet the requirement of the Boiler Code, it was necessary to interlock the gate valves so that one is always open when the other is closed or both open an amount equivalent to the full opening of one valve. This has been accomplished by providing one gate valve with a right-hand threaded spindle and the other with a left-hand threaded spindle and connecting them by means of sprocket wheels and chain, so that as one is opened the other is closed or vice versa.

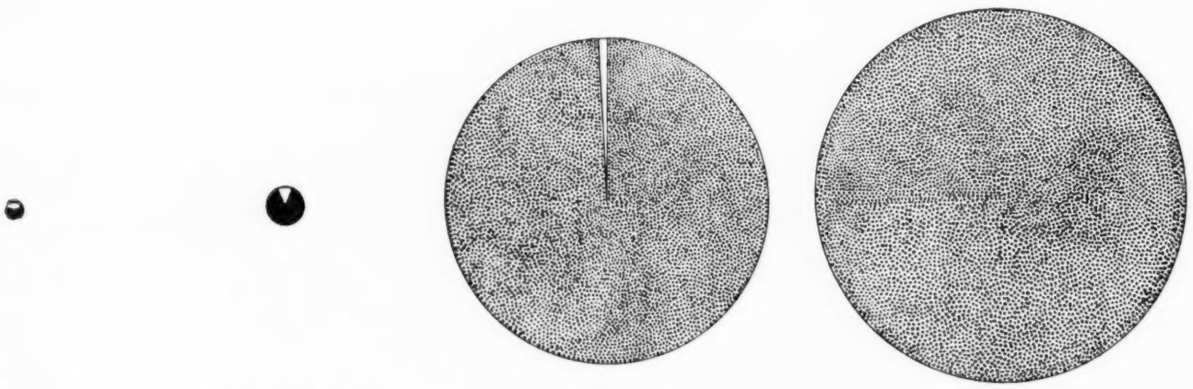


Arrangement permits adjusting or repairing safety valves without shutting down the boiler

The angle stop-check valve is of the toggle-top type and is designed for a working pressure of 450 lb. and a total steam temperature of 750 degrees.

Fuel Resources of the United States*

The areas of the circles are proportional to the heating value of the fuel supplies initially available in this country. The white sectors represent the consumption to date, and the black or shaded portions the fuel still available.



Petroleum	*Anthracite coal*	*Bituminous coal*	*Lignite*
42 per cent used; 8,500,000,000 barrels remain	15 per cent used; 17,000,000,000 tons remain	Less than 1 per cent used; 1,510,000,000,000 tons remain	Practically none used; 2,000,000,000,000 tons available

In heating value, the coal remaining is 1,370 times the remaining oil.

*Based on data presented to the power meeting of the Affiliated Technical Societies of Boston, Dec. 10 and 11, 1925, by F. H. Daniels, Vice-President, Riley Stoker Corporation.

Two Millions a Year for Science!

SUPPORT for new "national research professorships' is sought by the National Academy of Sciences to the amount of two million dollars yearly. While one unacquainted with present trends might think this too much to ask for such a project, a little study of history and the industrial situation should convince him that pure-science research is of such overwhelming importance as to justify almost any expenditure.

Needing money is one thing and getting it is another, but anxiety on this score should be largely relieved by studying the personnel of the board of trustees. Herbert Hoover is chairman. With him are A. A. Michelson, Gano Dunn, Vernon Kellogg, Elihu Root, Andrew W. Mellon, Charles E. Hughes, John W. Davis, Julius Rosenwald, Col. Edward M. House, Cameron Forbes, Felix Warburg, Henry S. Pritchett, Robert A. Millikan, J. C. Merriam, Owen D. Young, Henry M. Robinson, Simon Flexner and John J. Carty, along with prominent representatives of the universities.

If such men think this project worth pushing, its prospects are bright.

Boiler Legislation

THE legislatures of forty-two states were in session last year. Not a single one of them made any provision for state or municipal regulation of boilers.

In nearly two-thirds of these United States anybody can still put any old kind of a second-hand boiler under a sidewalk, in the basement of a department store, hotel, theater or factory without safety appliances or expert attention to the manner of its installation or operation.

Of course he does it at his own risk. He resents "governmental interference" and cockily assumes the responsibility.

He would be glad to build a frame building inside of the fire limits at his own risk—but he would not be permitted to do this. The responsibility to the community is greater than any one man can carry.

The responsibility is the same in kind if not in degree in the case of a boiler.

Have we got to have a Brockton disaster in each state before it will pass the needed regulatory legislation?

All that is necessary is for a legislature to endow the Department of Public Safety, the Factory Inspector or some appropriate department or official with the power and the means, if none of them has them already, to see that only safe boilers, properly equipped and installed, are operated.

The users of steam boilers ought to be glad of such supervision and advice when it is administered in a helpful and not a disciplinary spirit. They usually are in the states where such provisions are in force.

In the Boiler Code of the American Society of Mechanical Engineers such departments and officials have a definition and specification of what a boiler should be to be reasonably safe.

With this Code universally adopted or, at least, with boilers built to its specifications admitted to every state, the embarrassments of the boiler manufacturer with regard to conflicting state requirements would be largely avoided.

Where are all the committees and officers appointed to expedite such kindly expert supervision?

How many states may we expect to come into the fold during the coming year?

Air Preheaters and Cold Weather

THE advantages of air preheaters as a means for improving boiler efficiency seem to be generally recognized, and this equipment will be installed in many new power plants. These heaters take the air from the boiler room or from outside and preheat it on its way to the furnace. In winter time this air supply will be generally drawn from outside the power house. If taken from inside the power house, during the winter large volumes of cold air would have to be admitted into the boiler room, which would become cold and uncomfortable for the operators, while radiation losses from boilers, settings and piping would be increased and freezing troubles on blowoff and water lines might be encountered.

In general little difficulty will be experienced with the average air preheater when air is taken from outside, as the flue gases are not cooled down below two hundred degrees. It is now proposed to preheat air as much as five hundred degrees, and to do this the temperature of the flue gases must be lowered nearly to their dew point. If these air preheaters are designed to accomplish this result with normal air of sixty degrees, then consideration must be given to operation in extremely cold weather, which in certain sections of the country may mean temperatures of twenty to forty degrees below zero. It is quite possible under these conditions that the flue gases may be cooled down to their dew point or lower and condensation will result. This introduces the factor of probable corrosion of the air preheater plates as well as clogging up due to wet soot accumulations. This must be given careful consideration in air-preheater design.

One plan to prevent this trouble would be the provision of steam radiator coils at the air-preheater inlet, which can be furnished in cold weather with steam bled from one of the last stages of the main turbine. Sufficient steam may be furnished to keep the flue gases well above dew point; in fact, the steam admission may

be thermostatically controlled by leaving flue-gas temperature. Such use of bled steam for air preheating will tend to increase slightly the over-all station economy and should be favorably considered as a means of improving plant efficiency during the winter.

A "Super Library" for All Industries

PROBABLY America's most complete and valuable collection of engineering books and periodicals is that housed in the Engineering Society Building in New York City. There are, however, creditable technical departments in the public libraries of most of the large cities and in most university libraries. These treasure houses of practical information play an essential part in the sound development of industry, but something more is needed. That is a "super library" of industry as pictured by Dr. William W. Bishop, of the University of Michigan, at the recent Chicago conference of the American Library Association.

This would be located in some great center and contain, as far as possible, all books and periodicals of possible value to industry in general. Engineering would be just one phase of its service—though perhaps the most important one. Such a library would deal with everything of industrial value from engineering to applied psychology and from chemistry to cost accounting. It would be elaborately equipped with all the necessary machinery—photographic, stenographic, etc.—to render the maximum service to industries at a distance.

The idea seems to be a good one, as does also Doctor Bishop's suggestion that the "super library" be built up from one of the existing great technical libraries.

The Crank or Something Else?

EVERY now and then the "swash plate" mechanism bobs up with the air of a newcomer, for an engine or a pump. The latest appearance has been in the form of a Diesel engine for railway service. The advantages of the design are largely in its compactness. It gives a machine requiring small floor space and small headroom. Its disadvantages lie in the realm of stress and friction.

There is a widespread fallacy that the conversion of reciprocating motion to rotation is necessarily attended by great losses and that unusual devices for effecting the conversion involve smaller losses than the familiar slide-crank mechanism. Such is not at all the case. There are various mechanical schemes for accomplishing this conversion, and if friction could be eliminated, every one of them would involve no loss of energy whatever.

Friction loss is a function of bearing loads, lubrication, type of bearings and speed. In the familiar type of connecting rod and crank the only loss is in three rotary bearings, one oscillating bearing, and one reciprocating slipper. If these bearings are well made and effectually lubricated, the loss is relatively small. The swash-plate device similarly has two rotary bearings, and a number of slipper and oscillating bearings, depending upon the number of pistons used. Certain designs employ roller bearings, reducing the losses to astonishingly low figures, but even with plain bearings the losses need not be excessive.

Uniformity of torque is a consideration that brings to light the outstanding weakness of the simple crank and connecting-rod type of machine. Anyone who has ever barred an engine off dead center will readily admit this. But this pronounced characteristic must not be interpreted as indicating any loss of energy. The flywheel simply receives and returns energy during its revolution. None is lost save in bearing friction.

The flywheel usually necessary for the crank type of engine naturally increases its weight, but in most cases this is not a serious objection, and the weight can be reduced through the use of several cylinders.

Ease of operation and maintenance is an important item and is perhaps the great advantage of the crank and connecting rod, as evidenced by its universal use ever since it became available through the expiration of the patents which restrained James Watt from using it and forced him to turn to the Scotch yoke. Simple bearings and crosshead slippers are about as easy to keep in good adjustment as anything could be.

And so it is that the old familiar mechanism is after all a good one. For special use, novel devices may prove more satisfactory, but the engineer owes it to his lay friends to warn them against undue enthusiasm based on a misconception of the true situation.

Steam Tables Research

THE American Society of Mechanical Engineers, through a committee under the leadership of George A. Orrok, is fostering an unusually extensive program of research to establish reliable tables of the properties of steam up to high pressures and temperatures. The work is being done in three of the foremost laboratories of the country, by investigators whose skill and knowledge are unsurpassed.

Its great usefulness to the power industry lies in its effect on the design of steam-using machinery, whose detailed proportions must be laid out with reference to the density and thermal properties of the steam. A small discrepancy between the actual and the calculated values may give rise to a design of turbine blades, for example, whose efficiency is appreciably less than it might be.

Another point of contact with daily practice is in the calculation of plant and machine performance. In calculating the efficiency of a boiler, there is a difference of about two per cent between two of the principal steam tables now in use. In these days of high efficiency it is important to know which is correct.

The cost of the elaborate investigation necessary to establish tables of the accuracy demanded in engineering work is heavy, and the committee in charge has called upon the makers and users of steam equipment to contribute to its support. Thus far the response has been adequate, and it is to be hoped that, as new appeals are made, they may be met in the same spirit of co-operation in this splendid project.

In discussing a resolution pertaining to Muscle Shoals last week, Representative Huddleson is quoted as saying that "electricity is too expensive to be used in pulling street cars or for other utility purposes. It should be devoted to electric furnace operation where it is absolutely essential to those purposes requiring very high temperatures." This would be a rather dark and slow-moving nation if left to the dictates of some Congressmen.

Practical Ideas From Practical Men

Power is pleased to announce the awards of the judges for the first and second prize contributions received during November for this department in accordance with the terms of the contest.

The first prize of $25 goes to L. A. Pierson, of Devon, Conn., for his article on "The Case of Fusion Welding," in the Dec. 22, 1925, issue.

The second prize of $15 goes to Maurice C. Cockshott, of Hollywood, Calif., for his article on "Making an Unloader for an Air Compressor," in the Dec. 29, 1925, issue.

The judges were: (Chairman) Norman N. King, chief engineer, Singer Bldg., New York City; Willis Lawrence, mechanical engineer, Interborough Rapid Transit Co., New York City, and D. L. Fagnan, formerly refrigerating engineer, and more recently associated with the Smoot Engineering Corp., New York City.

Crushed Firebrick for Furnace Repairs

Reading the advertisements of manufacturers of plastic firebrick, I was induced a few years ago to try the material. As there were many furnaces in the plant used in process work, a great many firebricks were used and many tons of firebrick bats were hauled to the dump. This looked like needless waste, so I induced the company to buy a crusher so that we could use these bats in combination with a cement bond. Results were never up to expectation, big cracks would develop and the life of the work was short.

On one occasion we built one wall of a furnace and part of the front arch, using $80 worth of a high-priced cement, and the manufacturer's expert supervised the mixing and installation. The other wall and the remainder of the arch were done with a much cheaper cement. The high-priced cement was a failure, a crack about one inch wide extending upward from the grate line in the middle of the wall, with smaller cracks on each side. The wall had to be repaired in less than a year. The low-priced cement checked also, but will last twice as long.

About a year previous to this experiment a course of arch brick over a furnace door had worked loose, and as the bricklayer was busy at the time I decided to do the job myself and see if better results could be obtained. A year and a half later the marks of the form were still visible on the arch. This caused me to think that there must be something in the way the plastic material is used. So during the past summer I decided to mix and place the material myself, with the result that not a single crack has developed.

There is evidently something wrong with the rules for mixing given by some manufacturers of refractory cements, or results would be uniformly good, or at any rate the same, and if the rules are right, there should be repeat orders. For my own part, I have learned how the mixing should be done and can now depend on results. Of course the lasting quality of the job will depend on the quality of the refractory, both the cement and the crushed brick.

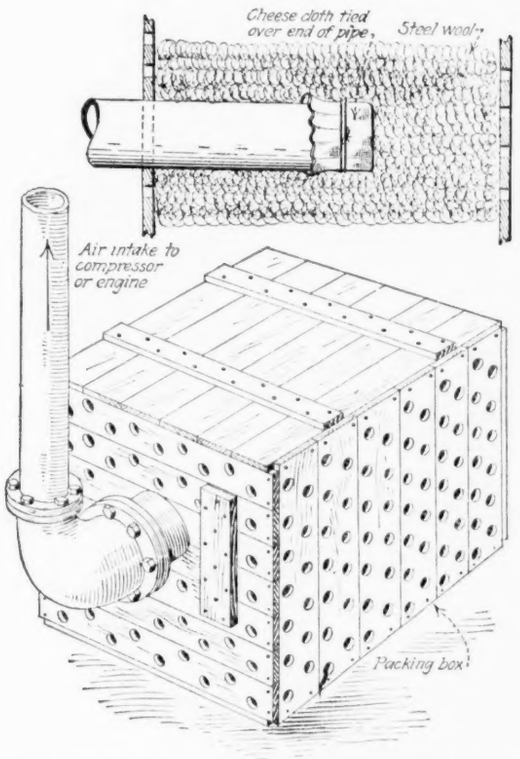
R. McLAREN.

Toronto, Ont., Canada.

Improvised Air Filter for Air Compressors

Air compressors are used in a great variety of industries, and clean air is the one essential for safe, trouble-free air-compressor operation. If the compressor is supplied with air free from dirt, sand and abrasive dust, it should operate at highest efficiency for long periods without needing to be taken down for cleaning or replacing parts.

If the air entering the compressors carries dust with it, the dust will be caught on the oily surfaces of the



End of intake pipe is embedded in oil-coated steel wool

discharge valves and form a paste that will cover and foul the valve seats. Since the air going through these valves is hot from being compressed, it will eventually bake the oil and dust into a hard carbonaceous deposit. This deposit causes leaking of the valves with a consequent loss of efficiency and increased temperature of the air due to the "wiredrawing" effect through the leaky valve. It is possible by repeated recompression

and wiredrawing of the same air to increase the temperature to a point where any oil deposits in the discharge line will be ignited and probably cause the discharge pipe to be overheated.

In addition to the fouling of the valves the dust particles tend to cling to the oily cylinder walls and wear down the piston rings, piston and cylinder walls of the compressor.

I know of one air compressor that wore out piston rings every month owing to its being in a dusty place. An air filter was made and put into use and had the effect of prolonging the life of the piston rings to six months before replacements were necessary. The installation of the filter was the only change made in the operation of the unit.

A simple air filter that I have found to be successful is shown in the illustration. It consists of a large wooden packing box with many 1-in. holes bored in the sides. The top of the box is loosely covered.

The intake pipe of the compressor enters through one side and extends to about the center of the box. The section of the pipe which enters the box should be as large as possible and may be made as much as twice the diameter of the regular intake pipe. Two thicknesses of coarse cheesecloth should be tied over the end of the pipe. When this is done, the packing box should be completely filled with a good grade of fine steel wool that has been dipped in air-compressor oil and drained. As the air is drawn through the box to the pipe, practically all the dust it carries adheres to the oil-coated steel wool and the air enters the compressor clean.

The only care that this filter needs is to have a small amount of air-compressor oil poured over the steel wool every week or so and to have the whole mat of steel wool removed about once a month and washed by dipping up and down in hot soap suds to which some soda ash has been added. The steel wool should then be well dried, dipped again in the oil and repacked into the box. The washing period depends, of course, on how much dust is collected.

The only troubles likely to be encountered are, clogging of the filter and oil getting into the compressor from the filter. The first may be avoided by washing or renewing the steel wool with sufficient frequency; the second may be overcome by draining the wool well before putting it in the box and not adding too much oil to it between cleaning periods.

A filter of this type could also be used for cleaning the intake air to gas, gasoline, oil and Diesel engines.

New York City. G. H. CORNELL.

Cleaning a Surface Condenser with Acid

Removing the scale from surface condensers with acid is not a new process. It has been used in many plants with varying success. The acids used are generally a weak solution of hydrofluoric or hydrochloric acid. The weak solution is used with the idea that the action of the acid upon the exposed metal will be the minimum, and is correct reasoning. With this weak solution it takes several hours to clean a condenser, often longer than it will pay to keep the condenser out of service, so with this idea in mind we set about decreasing the time required.

We calculated the amount of scale the condenser which we intended to try the experiment upon should have in it and the amount of muriatic acid that would be neutralized by this scale. From actual tests we found that the action of muriatic acid upon cast iron and brass was comparatively slow, so we decided to use the acid full strength.

As there was no pump of suitable size available, we rigged an air-lift of 1½-in. pipe. We connected the suction of the air-lift into the lowest point of the water chamber of the condenser and after removing the elbow from the water outlet of the condenser, we inserted the discharge from the air-lift into that opening. The valve on the water inlet to the condenser was closed and tested for tightness.

Everything being set, the acid was poured in through the same opening that the air-lift discharge was placed. When about 4 gal. of acid had been poured in, there was a violent reaction which caused foam to come through the opening. We had anticipated this and had provided a half-inch opening on the opposite end of the condenser to act as a vent, but this proved to be entirely too small. The action soon quieted down and more acid was added with the same results, so we continued adding acid intermittently until the calculated amount of acid was in the condenser. This amount of acid did not cover all the tubes, but the force of the air-lift and the violent action of the acid on the scale caused some circulation through the upper tubes. We kept the acid circulating for eight hours after the full amount had been added.

Upon opening the condenser we found a sludge which washed out readily. In the upper tubes, in addition to the sludge, there was a small semicircular piece of scale adhering to the top of the tubes; this also was washed out with water, as the acid had loosened it, although it had not fully decomposed it. The action of the acid upon the shell and tubes was not noticeable.

We have used this method now for two years with entire satisfaction. The action of the acid that is apparent is the erosion of the steel studs that act as staybolts for the heads of the condenser. The cleaning of this condenser with this method usually takes about 16 hours. Previous to trying this method we had tried baking and drilling. The baking was a failure. The drilling took over 24 hours and we had to use several different sizes of drills. Also it was practically impossible to keep the tubes from turning; in all the drilling was unsatisfactory. G. W. SEELEY.

Benson, Arizona.

Precaution Necessary When Removing Oil from Drums with Air Pressure

As it is the practice in many plants to remove the oil from barrels and drums by air pressure, I thought it might be well to record an accident that occurred recently in a railroad plant where this practice was being followed.

The oil in question was the kind used to lubricate car journals, which is of course rather a heavy oil. The drum containing the oil was placed beside the boiler for some time in order to raise the temperature so it would flow more freely. Later, it was removed to a shed and the air and oil line connections made to the drum. When the air pressure was turned on, the top was blown out of the drum and the workman who had made the connections was seriously injured.

It would appear that there is a certain element of danger in emptying oil drums in this way and that the greatest care should be exercised. B. W. HAY.

Bedford, Ind.

Comments from Readers

Keep up the Air Pressure

The editorial entitled "Compressed Air" in the Dec. 1, 1925, issue should provoke some discussion, as was perhaps its purpose. It certainly challenges remarks with its opening sentence.

"In many industrial plants," it is asserted, "compressed air is demanded at pressures higher than is really required." As an illustration is cited the use of high-pressure air for blowing chips, etc., when a much lower pressure would suffice. Such incidental use of air in the shop is not the service for which the air system is primarily installed. Well-equipped shops of any size today are laid out with air pipes generally accessible, and air at sufficient pressure is constantly available for many purposes. The pressure to be carried is that required for the most important and exacting units, say for the pneumatic tools.

Since the latter part of the preceding century efficiency and economy in compressed-air practice have advanced greatly, largely as a result of increased air pressures intelligently applied and controlled. The improved practice has not come by chance or by any reckless crowding for results. In rock cutting, the typical compressed-air industry, the one-man jackhammer, with suitable air pressure, has doubled the accomplishment of the old heavy rock drill mounted on its awkward tripod with weighted legs, all to be pulled down and set up again for each hole drilled. The suggestion that the portable and handy tools of today might be rebuilt with larger cylinders, with all that would entail, is a suggestion of retrogression which will not be followed.

There seems to be a misapprehension as to the function of the aftercooler. To begin with, it is now generally considered an essential detail of compressed-air equipment, and the belief has come as the result of actual practical and continuous experience, and to those who know the aftercooler best it certainly is not "simply a power waster." Although the air is made quite hot in the compression operation, its heat, as measured in thermal units, is astonishingly small. It readily loses the little actual heat that it carries as it goes along to its work or as it waits in the receiver or elsewhere, and when it is actually used it has fallen to about normal temperature, and has lost the increased volume which was due to the heat.

The aftercooler, therefore, by reducing the air to about normal temperature immediately it leaves the compressor, actually steals nothing of its working volume, but does put the air into a more workable condition by the abstraction of the superfluous water, the greatest annoyance and positive hindrance in the transmission and employment of the air. It acts upon the air at the precisely opportune moment, when it is at its highest pressure and smallest volume, for the release of the greatest possible amount of the water. With the aftercooler and the separator which must supplement it both functioning properly, the air will still not be dry by any means, but will be at the saturation point for the existing conditions. More than half of the contained moisture, however, will have been removed, instead of being carried along through the pipes.

Attention may be called to the actual working status of compressed air. The real argument for its use should seldom or never be that it is an economical agent in the transmission or application of power, for it is not, and it is not primarily as a power saver that it is generally employed. It is used because it does many things better, quicker and cheaper than they can be done by any other means, many things that could not otherwise be done at all, and it is not, therefore, as a direct and immediate power saver that it is usually employed. The incidental savings of time and money resulting from its use may exceed the total cost of the compression many times over, so that the net power cost of compressed air is often nothing at all. In such a case the statement that "in an existing plant the power saving is the only consideration" would not seem to apply.

FRANK RICHARDS.

Plainfield, N. J.

Why an Oil Engine Ran Away

Referring to the article by A. J. Nicholas, in the Nov. 17, 1925, issue on "Why an Oil Engine Ran Away," I wish to call attention to his last paragraph in explanation of the causes of his engine's behavior.

I cannot agree that these were the probable causes of this engine's running away. The particular engine mentioned by Mr. Nicholas operates with moderate cylinder compression and it is highly improbable that, with piston and rings so loose as to allow sufficient lubricating oil to pass by them into the cylinder to burn like fuel, the engine could have cylinder compression high enough to fire even when using a light fuel. Primarily because of their low compression these engines have never been able to burn a heavy fuel successfully, generally showing a marked tendency toward irregular firing on such fuel.

However, they do often show this tendency to run away, especially when first started, as I know from personal experience with them. But I have always attributed it to an entirely different cause from that stated by Mr. Nicholas. Usually, these small horizontal engines are not provided with air starting mechanism, and the customary procedure in starting is to heat the hot bulb, inject a few pump strokes of fuel into the cylinder by hand and roll the piston back against compression.

Often if the hot bulb is not sufficiently heated or if a fairly heavy fuel is used or if the compression is poor owing to worn piston, rings or cylinder, this may have to be done several times before the engine will fire. If considerable excess fuel is injected during these attempts to start, some of it may flow out the exhaust ports, but considerable of it may remain in the bottom of the cylinder and trapped in the cylinder

counterbore. When the engine starts rolling, of course, the fuel pump injects an excess of fuel until the engine comes nearly to speed and the pump comes under governor control, and by this time there may be sufficient heat to cause any fuel trapped in the cylinder to continue to burn until it is either consumed or swept out with the exhaust. The moving parts of these engines being of comparatively light weight, a few uncontrolled explosions in the cylinder after full speed is reached and no load on the engine, may result in dangerous overspeeding.

This, I believe, is a much more plausible reason for the overspeeding than that lubricating oil worked by the pistons in quantities sufficient to burn like fuel. Especially so, since in this design of engine there is always considerable pressure in the engine cylinder except for the small interval of time between the opening and closing of the exhaust ports, and with poor-fitting pistons or rings the natural tendency would be for excess lubricating oil to be carried back into the crankcase.

In one engine of the type mentioned by Mr. Nicholas, with which I worked, the tendency to run away was so pronounced whenever it was started up, that I piped water under pressure to a hole tapped into the transfer passage between the crankcase and the cylinder. When the engine started to overspeed, sufficient water was turned into the cylinder to kill the explosions.

Two-stroke-cycle engines with crankcase compression of scavenging air have run away also by carrying lubricating oil over from the crankcase to the cylinder. I recall one such engine, owned by an irrigation company, that was almost wrecked. After the disaster the engineer in charge said that the crank bearing had run hot, and to cool it quickly so he could work on it, he poured five gallons of light lubricating oil into the crankcase and rolled the hot crank down in the oil. After scraping and refitting the bearing, in the hurry to get the engine started and the pump running, he forgot to drain this oil from the crankcase. Upon starting, the engine promptly ran away, and only by the engineer's presence of mind in quickly flooding the cylinder with water was a complete wreck prevented. As it was, most of the bolts were shaken loose and the main frame cracked.

J. H. BENDER.

Clayton, New Mex.

Power-Plant Organization

There has been considerable discussion in the past months on power-plant organization, the shift system and the changing of watches.

It seems as if each plant should work on a system which, when tried out, has proved to be best adapted to that particular plant. Location of the power plant, the number of hours in operation and the size of the plant have considerable bearing on the system to be used.

For instance, in a plant of, say, 10,000 kilowatts and over, running continuously for 24 hours a day seven days a week, three shifts, changing watches at 6 a.m., 2 p.m., 10 p.m. or 8 a.m., 4 p.m. and 12 midnight seem to be ideal for the average plant. In most plants the day, or peak, load generally begins coming on about 7 a.m. or soon after, and this for one reason seems to be against the changing of watches at that time. The peak load of most stations of course must be early in the evening or very late afternoon whenever the motor load overlaps the lighting load as experienced during the dark winter afternoons. Moreover, it does not seem good practice to change watches throughout the station during any considerable change of load. Of course the time for changing watches is not a great factor in a base-load station that is running with practically a continuous steady load.

It does not seem practical to keep the same men on the same watches continually; rotating the three watches has proved to be beneficial to the men, the plant and the company by which they are employed. No two men will operate the same watch in exactly the same way; they both do their part, they both get there, but the observing chief has much to learn of his men and of the machinery under his care. He cannot be on the plant all the time, but by rotating watches he has the chance of seeing all his men, how they handle the machines, and how the machines act under varying operation. Considerable trouble can be avoided by correcting poor operation, and many times some one of the men has a good idea which, if adopted in the operation of a plant, may result in better economy.

What progressive engineer, fireman or oiler wishes to be on one watch continually? Men easily get into a rut and take the routine work as just a matter of "has to be done." Soon this routine work, etc., is carelessly done and many things that a different man would notice and correct or report for correction, naturally, are let go. Whenever there is a change of watch, the enthusiasm and interest the men take in their work are quite noticeable. Rotating watches puts new life and new interest into the whole station. Four weeks instead of two weeks on each shift has worked out to be the best, as it gives each watch a longer time to become better acquainted with the duties and operation of that particular time and yet is not long enough for one to acquire that power-house rut of doing routine work.

With regard to breaking up or separating the different men on the watches, it seems best to rotate, say, the watch engineers forward and the firemen backward, the helper and oilers changing in between the engineers and firemen and switchboard operators. This tends to keep a clique from forming among the men, and it is surprising how much each man on watch can learn and how much more efficient he will become by watching different men do similar work. It seems to broaden out his reasoning, makes him think more and shows him how many different ways there are to do the same thing. Then, should some trouble arise, he knows his method of overcoming it and also knows how the other fellows would do it, and soon he will adopt the quickest, most efficient and most reliable way himself. It is surprising how much constructive criticism goes on among men in a station on the different ways the different ones operate their watch and perform routine work.

Some chief engineers are fortunate enough to have plant engineers, consulting engineers or power superintendents over them. This makes things much easier, for how much better it is when repairs are needed or new equipment or some change be made, to go to a plant engineer who understands the matter and can readily see what is needed, than it is to go to some one who feels the power house is not to be considered anyway.

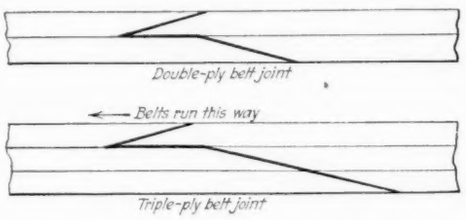
WILLIAM H. BARTON.

Somerset, Mass.

Making Leather Belts Endless

The remarks by Maurice C. Cockshott on "Making Belts Endless," in the Nov. 24 issue are generally good, but his method of joining three-ply belts is wrong, as it would leave the belt no stronger than a two-ply belt, and by concentrating the strain at the joints where each lap is broken, would cause it to break quicker than a two-ply belt. All belts should be joined on bevel scarf whether in making up the belt or fitting the final joint, being usually provided with a short scarf on one side and a long scarf on the other to give a longer and stronger joint. The exact cutting of the scarfs is not always as shown in the illustration, as an experienced belt man adapts them to the thickness of the individual plies of the belt at the point where he is making the joint so as to secure the greatest strength possible.

Another great convenience in making belts endless are clamp tension rods having right- and left-hand screws



Bevel-scarf type joint for double and single-ply belts

with ratchet handles, as the belt can be pulled up quickly and evenly on the two sides and the pitch of the combined screw is steep so that the force exerted on the handle is quite a fair measure of the tension put on the belt. The arrangement shown in the sketch accompanying Mr. Cockshott's article is not to be recommended, as the tension rods are not in the plane of the belt and would be bent as soon as an attempt was made to pull up the belt. In fact, considering the chances of spoiling a belt by overstraining it in pulling it up to make the splice or in pulling it out of shape in trying to run it on, if the joint is made off the pulley, I am surprised that Mr. Cockshott did not give more attention to this point. In this, as in a great many other operations, a little experience is worth a whole lot of advice or theory, but in general, in putting on a new belt or one that has been out of service for some time, it is better to pull it up fairly tight, let it stretch for a few hours and repeat the process two or three times rather than try to get all the stretch out at once with the chance of overstraining the belt. Different methods of tanning seem to give different stretches in belting.

Some belt makers are now arranging to run their belts on a pair of pulleys arranged to give sufficient tension to stretch the belt before sending it out for installation, and where a fixed center drive without an idler is desired on a machine where service is continuous, as in a paper mill, this is necessary, as a belt invariably stretches when first put into service.

It is an excellent idea, if an endless belt will not stay on the pulleys, and after checking up the shafting alignment, crown of the pulleys, tightness of the belt and finding them reasonably correct, to open up the joint and lay the belt out flat on the floor. Occasionally, one will be found, whether made from inferior material or strained in putting it on, which will be in the arc of a circle and which can never be made to work satisfactorily. By keeping a record of the purchase, date of installation, repairs, tightening, etc., of belts, such cases can be put up to the belt maker with much more prospect of obtaining redress than a simple unsupported statement that the belt was not satisfactory. Such belts can be remade and, by working them up into double belting where another layer will counteract the tendency to stretch on one side, can be made to give some return for their price. H. W. FISHER.

New Haven, Conn.

Gas-Engine Exhaust Heats Water Plant

When I read the editorial on waste-heat recovery in the Nov. 3, 1925, issue of *Power*, it made me wonder if there were not possibly a good many engineers besides myself who had made use of the waste heat from an oil or gas plant, without saying anything about it.

We have a municipal plant here that originally consisted of four boilers, a 500-hp. vertical cross-compound Corliss engine direct-connected to a 260-kw. alternator and a 750 gal. per min. duplex steam pump, with the usual feed pumps, heaters, etc. All of this is now standing idle, and power is generated by two natural-gas engines direct-connected to generators except when a break or failure of the gas line occurs.

The pumping apparatus comprises two 1,250-gal. per min. motor-driven centrifugal pumps, either one capable of meeting the demand for water. We have also a large filtration plant, with a storage capacity of 1,000,000 gal., which, while normally used only three or four months in the year, is kept ready to operate at a moment's notice and consequently, must be kept heated above the freezing point. A sectional boiler has been used for this purpose, as well as to furnish heat to the engine and pump rooms, gas being used for fuel, at a monthly cost of $60 to $100.

After a little study, I decided to utilize the waste heat being carried away in the exhaust gases. The exhaust lines of both engines were run into a common main, at an angle of 50 deg. Prior to connecting up the entire main, a gage was placed on the exhaust pipe a few feet from the manifold, but no pressure difference could be noted, even when both machines were operating in parallel. This exhaust main was run underground below the shop floor, to the filter plant around to the boiler room and then turned into the ashpit of one of the boilers. The gases, after heating the building, find their way up the boiler stack, keeping the water in the boilers at about 150 deg. F. in winter, and at about the boiling point in summer. Previously, the boilers were always drained in winter to prevent freezing, which caused considerable delay when the gas supply failed, which, however, occurred only twice during the last three years, and then in the winter. All piping used was 8-in. steel water main, with the tar and wrapping removed, and the joints made by reversing ends and electrically welding. Most of the bends were built up in the same manner, the work all being done by the staff. About 700 lin.ft. of pipe was used at a total cost of less than $400. We are not using up all the waste heat, and by adding more pipe, more heat would be recovered, but the whole plant is nice and warm, and a good return is obtained on the investment in the heating lines.

Macleod, Alberta, Canada. E. H. OLIVER.

What Happens and Why

A new slant on things observed in and out of the power plant

Newton Simplified

LONG years ago Isaac Newton packed into a few words his observations on the motion of bodies subject to outside forces. Ever since then his statement has filled the whole subject with an air of mystery, which is easily dispelled by a little common sense and consideration of what Newton really tried to say.

In the first place, we have what is known as *Newton's First Law*. Its formal statement is that action and reaction are equal, opposite and simultaneous. This is an elaborate way of saying something that is so simple that it seems almost unnecessary to say it at all. It means that a spring pulls just as hard on one end as it does on the other end, at the same time, and in opposite directions. There is certainly nothing mysterious about this.

If you stand on the floor, you push down on the floor to the extent of, say, 175 lb. Of course the floor pushes up on you to exactly the same amount, in an opposite direction, and at the same time. How foolish it is to state such simple things in such an elaborate way that they frighten people!

Mass and Weight Not the Same Thing

Another one of Newton's famous laws is the *Universal Law of Gravitation*, which states that the force of attraction between any two bodies is proportional to the product of their masses and inversely proportional to the square of the distance between them. What is this mass? It is simply the quantity of stuff in the body we are talking about. This law means that if we have two lead pencils lying on a desk, they attract each other with a force that is proportional to the product of their two masses, but the force in question is so exceedingly small that we never could detect it by any ordinary means. So far as practical considerations are concerned, the only case we are interested in is the attraction between various small masses and the earth.

Now since the quantity of stuff in the earth is constant, so far as we know, we can say that the force of gravitational attraction between the earth and various small objects near its surface is proportional to the quantity of stuff in the small objects, and inversely proportional to the square of the distance between the objects and the center of the earth. If we go a step farther and confine ourselves to objects at sea level, it will be entirely safe to say that the force with which they are attracted by the earth is strictly proportional to the quantity of stuff in the objects. Of course when an object is taken from sea level to high altitude, its weight changes and it becomes necessary to make corrections in the case of accurate work.

It is therefore entirely proper to find out how much stuff there is in a body (that is, to find out what the mass of a body is) by measuring the force of gravitational attraction between this body and the earth at sea level; that is, to weigh the body. The weight of an object at sea level is a proper measure of the mass or quantity of stuff that it contains. This is merely a very elaborate way of saying that it is better to buy tomatoes by the pound than by the dozen. Five pounds of tomatoes is a perfectly definite quantity of something to eat, while one dozen tomatoes may be more or less, depending upon their individual size.

Acceleration Proportional to Force

Now we come to the famous law of motion, which states that force is equal to mass times acceleration. As a matter of fact, this statement of the law is a modern modification of what Newton really said. He said that when a body is acted upon by a force, the acceleration resulting is proportional to the force, in the direction of the force and inversely proportional to the mass of the body. If we want to put this in the form of a mathematical equation, we may write it this way:

$$Acceleration = \frac{force}{mass} \times constant$$

Now we have just seen that the mass of a body is measured in a perfectly sensible and reliable way by weighing the body at sea level. If we don't happen to be at sea level, we may weigh the body on a beam or platform scale which mechanically compares it with standard iron or brass weights, which themselves have been weighed at sea level. If we must use a spring scale at higher altitudes, then we shall have to make corrections to determine what the weight of the body would have been at sea level.

Now let us turn this equation inside out for a moment and write it this way:

$$\frac{mass}{constant} = \frac{force}{acceleration}$$

This says that the mass of a body (whatever it may be) divided by some unknown constant, is equal to the force acting on the body divided by the acceleration that results from the action of that force. Now what shall we do about this unknown constant? Well, the easiest thing to do about it is to rewrite the equation in such a way that we may forget it.

Suppose we take any particular body and find one pair of values for force and acceleration which can easily be determined. Such a pair of values is the weight of the body at sea level and what we call the acceleration of gravity at sea level, which has been accurately determined by a great many experiments to be 32.17 ft. per sec. per sec. That is, the velocity of a body falling in a vacuum increases 32.17 ft. per second each second. This makes it possible to rewrite our equation in the following way:

$$\frac{mass}{constant} = \frac{force}{accel.} = \frac{weight}{32.17}$$

Now let us drop the first member of this equation, which leaves us an equation as follows:

$$\frac{force}{accel.} = \frac{weight}{32.17}$$

or

$$force = \frac{weight}{32.17} \times accel.$$

This is the equation that we really use. It says that for any particular body the acceleration is proportional to the force acting on the body.

Law Has Many Practical Applications

This formula has many applications in engineering. Take the case of a flywheel with 1,000 lb. of metal concentrated in the rim, the weight in spokes and hub being relatively unimportant so far as turning is concerned. Assume also that the crankshaft is disconnected from the connecting rod and that the friction of the main bearings is negligible. With these assumptions, if a man should start pulling on the rim, the entire force exerted would be used in producing acceleration. This acceleration could easily be figured by the formula just given.

Let us suppose that the man exerts a steady pull of 100 lb. tangential to the rim. Then, putting 100 for "force" in the formula and 1,000 for "weight," we have:

$$100 = \frac{1{,}000}{32.17} \times acceleration$$

or

$$acceleration = \frac{32.17 \times 100}{1{,}000} = 3.2 \; ft. \; per \; sec. \; per \; sec.$$

This means that, if the steady pull of 100 lb. is maintained, the rim will be moving at the rate of 3.2 ft. per sec. at the end of the first second, at the rate of 6.4 ft. per sec. at the end of the next second and so on. Actually, of course, as the speed increased a point would be reached where the man could no longer maintain a steady pull. Even if he could, air resistance would eventually limit the speed at which the flywheel could turn.

New and Improved Equipment

Uehling Waste Meter

An instrument known as a waste meter, designed to record the temperature of the flue gases at the boiler exit and the percentage of CO_2 on the same chart, has been brought out recently by the Uehling Instrument Co., Paterson, N. J. The instrument combines the Apex CO_2 meter brought out about a year ago by this company and described in the Jan. 13, 1925, issue, and a pyrometer to record the temperature of the flue gases.

Fig. 1—Combined pyrometer and CO_2 recorder

The pyrometer element is operated by the varying quantity of air that will flow through an orifice at different temperatures. Referring to Fig. 2, air is drawn in succession through the two orifices *A* and *B* under constant suction. Orifice *A* is at the temperature to be measured, while orifice *B* is maintained at a constant temperature.

So long as the air has the same temperature in passing through *A* as it has in passing through *B*, there is no change in the partial vacuum in the inclosed space between the two orifices; if, however, the temperature of orifice *A* increases, while that of *B* does not change, then orifice *A* will offer greater resistance to the inflowing air and in consequence the suction or vacuum between the orifices will increase.

In the application of this principle to the pyrometer, orifice *A* is located in a tube which is exposed to the heat to be measured, while orifice *B* is kept uniformly at 212 deg., by the exhaust steam from the aspirator of the CO_2 element. Adequate filters are provided for keeping the orifices clean.

Orifice *A* is made of platinum and is located at the end of tube *C*, Fig. 2, which is protected by an outer tube *D*, the inner tube connecting with orifice *B* by copper tubing *E*. Air from the atmosphere is drawn through the petcock and filter *F*, as indicated by the arrows, and passed between the inner and outer tubes, where it is heated to the temperature of the flue gas and then passes through orifice *A* at this temperature. The amount of air that enters *A* depends upon its temperature, and this air is carried through tubes *C* and *E* to orifice *B*.

The fire tube *D* is located in the last pass of the boiler or wherever else it may be desired to record the temperature, and the changing vacuum between the orifices is transmitted through tube *G* to the temperature side of the meter, where it actuates a bell floating in mercury to which is attached the recording pen. The pen travel is calibrated in degrees for the desired range of temperature.

For actuating the CO_2 pen of the instrument, the Apex meter previously referred to is employed. The latter instrument is similar to the pyrometer element just described excepting that its orifices are both maintained at the same temperature and the changing vacuum between the two orifices depends upon the absorption of the CO_2 constituent of the gas by means of a dry cartridge. The constant steam aspirator of this meter also develops the necessary suction for the pyrometer element.

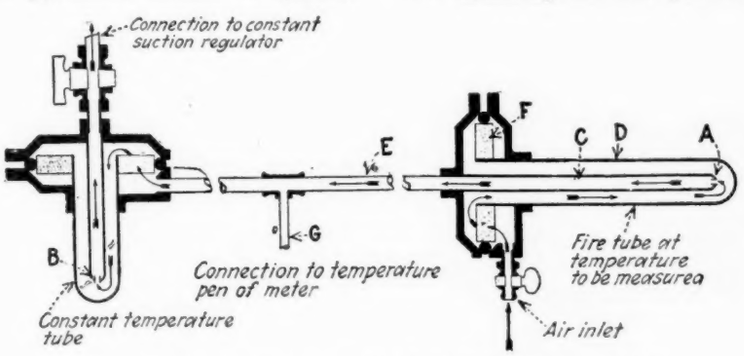
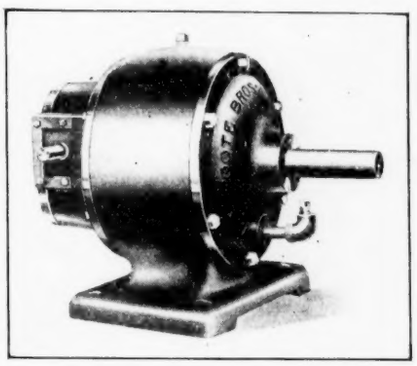


Fig. 2—Illustrates the principle of pyrometer operation

Foote Right-Angle Drive Speed Reducer

To meet the requirements for reduction gears that will operate in confined spaces where sufficient room is not available for straight-line drive units and where it is necessary to change the direction of power drive, the right-angle-drive speed reducer shown in the illustration has been developed by the Foote Bros. Gear & Machine Co., Chicago, Ill.



Right-angle-drive speed reduction unit

The reduction unit is similar to the standard straight-line drive unit manufactured by this company, except that the high-speed shaft projects at right angles to the axis of the slow-speed shaft, the change in direction of the power drive being accomplished by means of bevel or miter gears, mounted in the high-speed end.

The high-speed pinion is made integral with the high-speed shaft and delivers the power through three idler gears set at 120-deg. angles to a large rotating internal gear, the internal gear being fastened to the slow-speed shaft. The unit is designed with liberal sleeve bearings, and ball bearings are used to take care of the thrust set up by the bevel or miter gears.

By changing the size of the pinion and internal gear and the relative size of the bevel gears in the high-speed end, almost any desired relation may be obtained between the speeds of the high-speed and low-speed shafts of the unit.

The reduction units are made in a variety of standard sizes and in capacities ranging up to 150 hp. and reduction ratios up to 350 to 1.

Protex Portable Socket

Designed primarily as a "safety first" device, the Protex portable socket cover shown in the accompanying illustration has a useful field in extension lamp service. In the power plant it has particular value for boiler inspection or

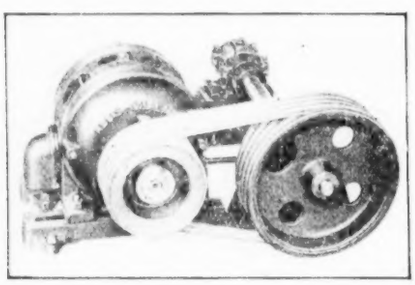
Portable socket cover

other work where moisture tends to increase the danger to the user from short-circuits or grounding. The handle is made of a high-grade rubber compound and is proportioned to withstand the abuses common to the service. For switchboard inspection the wire guard is insulated to prevent possible short-circuiting. Guard and socket as a unit are being supplied by the Daniel Woodhead Co., 15 North Jefferson St., Chicago.

"Texrope" Drive

The illustration shows a short-center flexible drive, known as the "Texrope" drive, recently brought out by the Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

The new device consists of two grooved sheaves and a number of endless V-belts, the sheaves being set just far



Short-center flexible drive

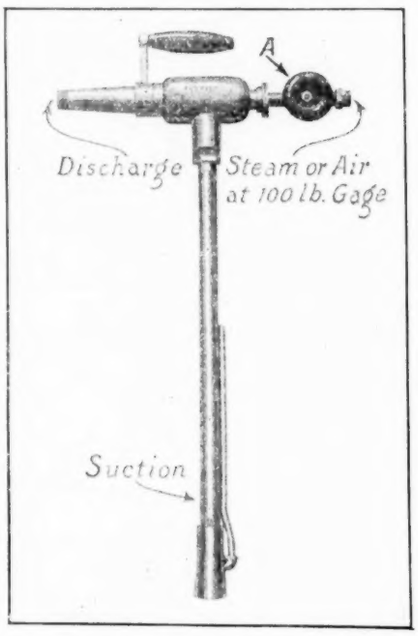
enough apart so that the belts fit the grooves without either tension or slack.

The belts are to some extent elastic and stretchable, which tends to remove the jerks or vibrations when starting, accelerating or running, and as no belt tension is used, the bearing pressures are low.

The drives are available in sizes from ½ to 250 hp., with ratios up to 7 to 1 and belt speeds from 800 to 6,000 ft. per min. and are adaptable for driving blowers, refrigerating machines, paper machines and similar services.

"Carboplastic" Gun and Refractory Cement

Two new products in the field of refractories recently brought out by the Carborundum Co., of Niagara Falls, N. Y., are a cement called "Carboplastic," and a gun for applying the cement to the interior of furnace walls. The principal ingredient of the cement is carborundum, and it is made to inherit the refractory properties and at the same time lend itself readily to application with the "Carboplastic"



Gun for applying cement

gun shown in the illustration. The new cement is prepared for use simply by the addition of water to give it the proper consistency.

The gun for applying this cement is portable, weighing but 12 lb. It has no moving parts and is operated by a single valve *A* located close to the handle. The gun is operated by either steam or air at 100 lb. pressure.

S. C. Regulator Mfg. Co. Type "S" Valve

Where several boilers are supplied with feed water from one pump, controlled by a differential pressure regulator, the excess pressure on the feed line tends to vary materially at each boiler with changes in the rate of feed.

With a view to eliminating this variation in the excess pressure, an automatic regulator or control valve designed especially for installation in the line just ahead of each feed-water regulating valve has been brought out by the S. C. Regulator Co., Fostoria, Ohio. The general constructional features of the valve are shown in the illustration, Fig. 1, which is self-explanatory.

The opening through the valve is controlled by means of a diaphragm having steam pressure on one side and feed-line pressure on the other. The steam-pressure connection is made to

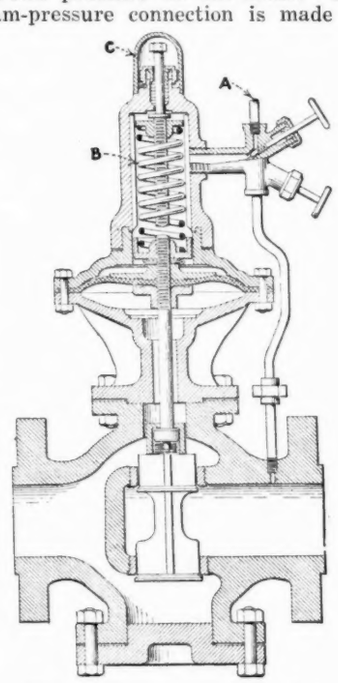


Fig. 1—Type S control valve

the valve at the point *A* and adjustment for the excess pressure desired is obtained by altering the tension on the spring *B*.

In addition to controlling the excess

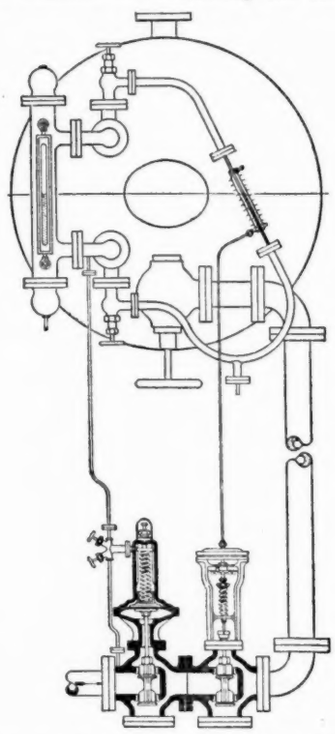


Fig. 2—Application of control valve

pressure ahead of the individual feed-water regulating valve, the type S valve can be used in the discharge of an electrically driven boiler-feed pump to maintain a constant excess pressure on the feed line.

Lubrication in Refrigerating Plants*

Importance of Proper Oil for Ammonia and Carbon Dioxide Compressors—Requirements of a Correct Oil and Consequences Following Use of Unsuitable Oil—Application of the Oil, Proper Drainage, Oil Recovery and the Avoidance of Oil Stains

By THOMAS M. GUNN
Technical Department Vacuum Oil Company

THERE is probably no class of mechanical equipment in which the use of correct lubricants and correct methods of application are so vital as in refrigerating machinery, as, unlike most other machines, the use of incorrect lubricants and methods of application may result not only in wear and leakage, but also in the obstruction of various parts of the system so serious that the economy and capacity will suffer.

Requirements of Correct Oil

The majority of lubricating oils become solid at the temperatures produced in refrigerating machines and, if used will gradually coat and clog essential parts of the system. Hence, an oil must be used that will remain fluid at low temperatures, in other words, have a "low pour test."

Many oils possessing a low pour test are chemically unstable, break down and leave behind deposits that are even more difficult to remove than a congealed oil. The breaking down of such oils also may produce gases that interfere with the action of the condenser and produce high head pressures. Chemical stability is, therefore, an added requirement of the oil.

An oil may possess low pour test and be chemically stable and still be unsuitable for the effective lubricating and sealing of the machine parts. The majority of oils of low pour test have insufficient body for this purpose. This is easily understood when it is recalled that the discharge temperature is about 150 deg. F. for carbon dioxide machines and about 230 deg. F. and often higher for ammonia machines. The oil must have sufficient body to maintain the lubricating and sealing oil film at cylinder temperatures.

Some oils, produced by mixing light and heavy oils, become separated into their component parts through the action of the heat of compression. This tends to leave behind the heavier oil, which bakes, forming objectionable deposits. To avoid this, the oil must be homogeneous; that is, its component parts must be sufficiently similar in character so that they will not become separated by heat. An abnormally low flash point would be an indication of a non-homogeneous oil, unsuitable for the service. Aside from this, the flash point gives little or no indication of the value of a refrigerating oil.

Many refrigerating machines are so constructed that a single oil must be used for bearings as well as for cylinders. The oil must, therefore, be suitable for bearing lubrication. Where splash and circulation systems of lubrication are employed, the oil also must have the high degree of purity which renders it capable of undergoing this severe treatment for indefinite periods of time without deterioration or the formation of sludge, emulsion and the like.

Experience has demonstrated that some oils are far better lubricants than others. Even two oils closely similar in all other regards may show a difference in this characteristic, which may be called "lubricating value." High lubricating value is important in a refrigerating oil.

Consequences Following Use of Unsuitable Oil

In the compressor cylinder inadequate lubricating qualities of an oil will result in rapid wear of piston rings and cylinder walls, and insufficient oil body will lead to failure of the oil seal, and by permitting leakage past the piston and valves, decrease the capacity and efficiency of the compressor. Lack of oil seal in the stuffing box necessitates tightening the gland, where soft packing is used, producing excessive friction, piston-rod wear and a hot stuffing box.

The compressor discharges gas at a high temperature. An unstable oil breaks down, forming gummy deposits that cause piston rings to stick and leak; also forming carbon deposits around the valves and delivering to the condenser the products of a cracked oil, consisting of heavy hydrocarbons that foul the condenser surface and gaseous hydrocarbons that build up high head pressures. These conditions tend to decrease the efficiency of the condenser and by compelling the compressor to deliver gas against an unnecessarily high head pressure, waste power.

An oil that will congeal in the evaporating coils builds up an insulating coating on the interior of the heat-transfer surface which resists the absorption of heat. A foul condition of the heat-transfer surface necessitates reducing the temperature of the evaporating ammonia or carbon dioxide to maintain the absorption of the required amount of heat. This in turn demands a lower back pressure to produce the required temperature.

The consequences of an unnecessarily low back pressure are well known, but an example will be appropriate at this point.

Assume that a certain machine is operating on a head pressure of 150 lb. gage and a back pressure of 18 lb. gage when the coil surfaces are clean. It has been demonstrated that only a small quantity of congealed oil in the coils will require reducing the temperature of evaporation by 15 deg. or more. A simple calculation based on the properties of ammonia shows that the result of decreasing the temperature of evaporation by 15 deg. will require 26 per cent increase in the power to produce a given amount of refrigeration. Still worse than this, the capacity of the machine is simultaneously reduced by nearly 30 per cent. This is only the theoretical loss. In practice the loss of capacity is generally greater than is shown by calculation, and it will be realized that conditions may be much worse than those assumed in the example.

These consequences also may follow the use of an oil of amply low pour test but of an unsuitable quality. It has been mentioned that an unstable oil may break down and form deposits in the condenser. These deposits also may occur in the evaporating coils, in which case they are more difficult to remove than congealed oil and are equally destructive to plant capacity and economy.

These deposits from broken-down oil may clog the expansion valve or may be carried into the suction of the compressor, where they have been known to prevent the proper action of the suction valves; or into the crankcase, where they may stop the access of oil to the bearings.

Application and Drainage

If it is possible to feed the oil for internal lubrication in small quantities, the quantity of oil passing into the system will be reduced to a minimum. This, however, reverts again to the question of oil quality, since an oil of high lubricating value can be used much more sparingly than another, while still maintaining an effective lubricating and sealing oil film. Not all methods of application make it possible to feed the oil in small quantities. It is difficult, though not altogether impossible, in a splash-oiled compressor to control the quantity of oil reaching the cylinder walls. In horizontal, double-acting compressors, the method of lubrication providing best oil control is the use of a mechanically operated force-feed lubricator delivering by two separate feeds, one to the lantern of the stuffing box and the other direct to the cylinder walls. This method may sometimes be applied to large vertical compressors.

In any refrigerating plant it is important to provide effective means for draining oil from the system, and doubly so where the design of the compressor or method of oil application makes it difficult to control the quantity

*From paper read at the sixteenth annual convention of the National Association of Practical Refrigerating Engineers, Detroit, Dec. 9-12, 1925.

used. The oil separator in the compressor discharge pipe should be located as far from the compressor as possible to increase its effectiveness. The separator can remove that part of the oil that happens to be in the form of drops, but atomized or vaporized oil will be carried directly with the gas to the condenser. There should, therefore, be some means of draining oil from the condenser.

In most cases the oil will drain from the condenser to the liquid receiver, and here is a means of collecting and withdrawing the oil that is seldom used as effectively as it might be. Practically all lubricating oils are nearly 50 per cent heavier than liquid ammonia. If given an opportunity, the oil will settle to the bottom of the liquid receiver from which it may be drawn off from time to time.

The majority of liquid receivers are not designed particularly with this point in view, and consequently permit some oil to pass through the expansion valve into the coils. In several plants, liquid receivers have been installed of a design that will permit almost perfect separation of oil from the liquid ammonia, with the result that, after several months' operation, only a few pints of oil have been found in the evaporating coils or brine cooler.

The low-pressure side of the plant should have suitable drain connections. It is advisable to provide some form of drain pocket in which any oil present may collect and where it will be out of the path of flow of the ammonia liquid and gases. When this is done and a suitable oil is used, it is often possible to drain oil completely from the coils without any shutdown whatever.

Between the coils or brine cooler and the compressor it is customary to install a scale trap to prevent pipe scale from returning to the compressor. Depending on the arrangement of the installation, it may be desirable to install a separator capable of catching any liquid that may be present in the suction gas. If oil is carried to this point, this separator also will serve the purpose of collecting the oil.

Oil Recovery and Filtration

The use of a purifier or regenerator for the recovery of oil has many advantages. When no purifier is used, there is a tendency for the operator to neglect the draining of the oil from the system, on account of the unpleasantness of the operation. With one installed, oil from various drainage points is collected in the purifier, the ammonia present is boiled off, and the oil is drawn out in a fairly pure condition and without loss of oil or ammonia.

The oil recovered in this way may be filtered by any of the customary methods. In any plant, simple filters may be made in which the oil will be strained through several thicknesses of cloth. Somewhat better results are possible by the use of one of the several types of filters on the market. Centrifugal separators, when available, give excellent results, but should first be thoroughly cleaned of any other oil in the bowl.

Location of Thermometers

When the correct high-grade oil is first installed in a plant in which an inferior grade of oil has been in use, there is frequently an initial period of trouble. The oil previously used may have broken down, leaving gummy deposits over the interior surfaces—deposits so heavy that they could not be cleaned out readily even by steaming. It has been found that correct high-grade oils have a tendency to cut loose these gummy deposits. The floating pieces of gum sometimes clog the expansion valves, and, after rolling about in the evaporating coils, form balls, some the size of a marble, which are either caught in the scale trap or carried to the compressor suction valves. The smaller particles of gum may reach the crankcase and there becoming partly melted by agitation and higher temperature, are again deposited on the interior surfaces when the machine cools off. In the bearings this material may cause difficulty in starting the compressor.

These initial troubles are overcome by giving the machine and all the piping a thorough cleaning after the high-quality oil has been in service for sufficient time to loosen up these deposits. After such a cleaning there is no repetition of this trouble and the efficiency of the plant is much higher than before, because the insulating coating of deposits has been removed from the heat transfer surfaces.

Avoiding Oil Stains in Ice

In raw water ice oil stains occasionally appear due to oil carried by the compressed air from the air-compressor cylinder. The first step in the avoidance of these oil stains is to reduce the oil feed to the air-compressor cylinder to an unusually small quantity, which is possible only when a correct high-quality oil is employed. In addition to this the dehydrator or other apparatus used for washing, cooling and drying the air and for abstracting the oil should be kept clean and in good order. This washing, cooling and drying apparatus removes the oil by congealing it. A refrigerating oil will not congeal. Therefore, it is a mistake to use the refrigerating machine oil for the air compressor because it will be carried over into the ice cans. A high-quality air-compressor oil should be used.

In the majority of distilled-water ice plants the water for ice making is obtained by condensing the exhaust steam from the engine. To avoid cylinder oil in the distilled water, it is necessary to keep the grease extractor, reboiler, skimmer and filters or deodorizers in good operating condition and to reduce the cylinder-oil feed to the smallest quantity that will satisfy the requirements of lubrication.

Experience has shown that the correctly compounded cylinder oil, owing to its high efficiency as a lubricant, can be fed in such small quantities that any oil in the condensed steam can be removed completely before it reaches the cans. The use of a compounded oil, however, should be limited to cases where the equipment used and the attention given to its operation will assure that a minimum oil feed always will be maintained. When the method of steam-cylinder lubrication does not permit the use of a small oil feed or when close regulation of the feed is not feasible, it is necessary to use a pure mineral cylinder oil, which will separate more readily from the exhaust steam.

Transmission of Power[1]

THE problem of transmission of power may be defined as follows: "From a point *A* where mechanical energy is available in a certain given form, to transport the energy in such a manner that it will be available at a point *B* in the desired form." For instance, at the point *A* the energy may be available in the form of a gallon of gasoline, and it may be required ten miles away in the form of water raised to a certain level. This could be done in many ways and in each of these are many variables. However, in every case some of the energy must be lost on the way from *A* to *B* and in the transformation from one form to another.

Unavoidable Losses

It is obvious that for any transportation or transformation of energy there is a loss, but it is not so obvious that a portion of such loss is unavoidable. Not only is there a loss when the energy changes form, but there is a definite and unavoidable minimum loss when it changes position. The author thinks that this absolute minimum is the same no matter what the system or method of transport.

Systems of transmission may be classified as mechanical, fluid or electric, and there are general principles common to all transmissions, no matter in what class or in what manner the transmission is obtained.

With regard to hydraulic transmissions the lecturer said it might be thought that by changing the system from the circulating type to an oscillating type the efficiency could be improved. This, however, is not the case. After a long research the author has concluded that there is a fundamental connection between all transmissions in which liquids are used as a medium, and that, from the efficiency point of view, it does not matter what the system is or what are the pressures or velocities preferred.

Loss in Fluid Transmission

The handicap to high efficiencies in fluid transmission is not in lack of precision in manufacture nor in the suitability of the system adopted, but merely the basic principle of hydraulic transmission. There is an unavoidable loss because the energy passes abruptly from one form to another. For example, if the energy is available at the shaft of a prime mover in the form of a rotating torque, the "transformation" of this form of energy into a "hydraulic" form is accompanied by a loss and it does not matter by what means the transformation is made; the effi-

[1] Abstract of a paper entitled "Transmission of Power—The Present, the Future," presented by G. Constantinesco at a meeting of the North East Coast Institution of Engineers and Shipbuilders, held at Newcastle-on-Tyne, England, on December 4, 1925.

ciency of transformation depends only on fixed constants defining the fluid itself. Matters seem to be so nicely balanced that when the designer tries to improve one thing, something else suffers, and the only possibility is a compromise which gives the maximum possible efficiency. Even with an entirely different mechanism, the result of the best compromise is the same maximum efficiency.

High-Efficiency Mechanical Transmission

Among the electric, fluid and mechanical methods it is only the last that has shown a possibility of obtaining efficiencies of a high order, and there is an absolute limit to the possible efficiency. The author thinks that it has already been attained in some mechanical transmissions, such as link motions, gear wheels and the like. An efficiency of 98 per cent is often cited as having been obtained. However, such figures are subject to more careful investigation as the methods used for measuring high efficiencies are not free from possible errors. In any case, one may safely say that efficiencies of the order of 95 per cent are practical possibilities for almost any mechanical transmission of moderate power when carefully designed. For the present, hydraulic or electric transmissions may be credited with possible over-all efficiencies of 85 per cent. From the efficiency point of view alone there appears to be no doubt that mechanical transmissions are superior to electric or fluid transmission, and if the latter can replace mechanical transmissions in certain cases, it is only because of convenience. For the present it is certain that for short distances an overwhelming case can be made in favor of mechanical transmissions.

At light loads the efficiency of *any* transmission falls more quickly than for heavy loads. Therefore, it is advantageous from the efficiency point of view to overload rather than to underload.

Wave Transmission

With regard to the method of transmitting energy by "wave transmission," in which the liquid does not circulate, this method appears to lend itself to simple generators and motors; furthermore, only one pipe is necessary for the transmission. The mechanism necessary for a "wave generator" or "primary" is an ordinary hydraulic pump without any valves, and for the "secondary" or motor a similar machine is used. Therefore all the elements of the transmission lend themselves to extreme simplicity. During the war the author investigated its possibilities and succeeded in applying it to synchronizing machine guns on airplanes, to enable them to fire through the propeller. The system was adopted and used on practically all British fighting planes.

The wave method is simpler than the hydraulic method when the speed ratio is invariable. For a variable transmission a valve system is required in the wave motor exactly as in the ordinary hydraulic motor, and the advantage of simplicity disappears.

For long distances electric transmission seems able to maintain its position. For moderate distances electric and fluid transmissions of the circulating type can show good results so long as the speeds and pressures are maintained fairly constant and near the values that conduce to peak efficiency.

Mechanical transmissions are not sufficiently advanced for the present for continuous variation of load and speed, but recent developments in this direction are promising.

In belt drives, gears, hydraulic transmissions with fixed-stroke pumps driving fixed-stroke motors, alternating-current dynamos driving synchronous motors, etc., a change in speed ratio is possible only by altering the dimensions or arrangement of the parts themselves, as by changing the diameters of the wheels, number of poles of electric machines, etc. Such transmissions may be called "synchronous transmissions."

Asynchronous Transmissions

A special type of such transmissions in which the speed ratio can be varied, but only at the expense of energy, may be termed "asynchronous transmissions." Such are all combinations of slipping belts, slipping clutches, hydraulic mechanisms using a bypass, alternating-current motors of the squirrel-cage or slip-ring types, etc.

An important group is the type of variable transmissions, and finally comes the group of automatic transmissions. All transmissions may therefore be divided into four groups: Synchronous, asynchronous, variable and automatic.

With regard to hydraulic transmission in which pistons, vanes, or ports are used, it appears that oil is not the best liquid. The viscosity of oils is extraordinarily variable with temperature, and it appears necessary that the temperature of the oil must somehow be maintained constant not only for the sake of good lubrication, which is fairly easy, but, what is far more important, for the sake of maintaining efficiency. Efficiency will vary considerably for even moderate variations in the temperature of the oil.

Water Preferable to Oil for Hydraulic Transmission

The author has obtained consistent results when using water in preference to oil in wave-transmission experiments. When oil was used there was a decided fall in efficiency with the increase of oil temperature. To maintain efficiency it is necessary to select liquids that will maintain the same viscosity and lubricating properties when the temperature changes. This is difficult to do because the average efficiencies of hydraulic transmissions are not high and there is considerable heat generated which it is difficult to radiate quickly. Water radiates easier than oil, and this should make it preferable to oil if it is possible to use it without introducing other difficulties.

Future transmissions will probably be well-balanced combinations of electric, fluid and mechanical systems, each field supplying the parts missing in the other fields in such proportion that the resultant combination will be better than any system separately.

What About Coal?

By Hugh Farrell

Look around and try to think of something that is in worse shape than the bituminous coal industry. If you have any money invested in it, you probably feel that it has already passed through a revolution. As a matter of fact it has, but even the industry itself doesn't know what kind of a revolution it was that knocked it into the cocked hat that it is today.

Everybody knows that the bituminous coal industry is over-developed, so is the oil industry, so is farming, so are tens and perhaps a hundred of other industries over-developed. Over-development is an economic crime which our laws and prejudices laboriously encouraged until the recent decision in the trade association cases, but while other industries have managed to make some progress in the face of over-development, the bituminous coal industry has made none, none whatever.

Just the contrary, the bituminous industry has actually lost ground. All of its troubles have not been due to the fact that it had a potential capacity and an occasional output far in excess of the country's need—practically double its needs, in fact. At one time there was perhaps some hope that the country would grow up to the potential and often actual capacity of the industry. Instead the country has steadily managed to do amazingly more work with less coal—the current annual rate of consumption is no greater if it is as great as that of ten years ago. This is true of anthracite as well as of bituminous.

The fact that the anthracite industry has practically stood still for ten years shows that all the troubles of the coal industry are not due to over-development and the uncontrollable factor of labor. The eternal bickering that has kept the industry in the public eye for nearly twenty years may have acted as an accelerator of the progress of science which made it possible for coal counsumers to do more work with less coal, but these contributions to proggress were unwittingly made, and the attention that the industry has been forced to give to internal strife has perhaps lost opportunities, which, if made use of, might have made this a different story.

It is certain that the coal industry could have reaped some of the profits that have gone to outsiders if it had studied the possibilities of coal as much as others have studied them. The decrease in the demand for coal is a result of scientific progress in the control and utilization of heat, and would have come about regardless of the research activities of the coal industry itself, had there been any, but if the industry had known what was coming, it might have managed to keep the control of the thing it had to sell—power—in its own hands. The industry not only did not know what was coming; it does not even know what has come, and has not the faintest conception of what is yet to come.

*Extract from "What Price Progress," issued by the Chemical Foundation, Inc.

News in the Field of Power

Muscle Shoals Main Switchboard in Operation Now

Four Generators Have Met Tests Satisfactorily—Four Other Generators Ready in Spring—Government to Install Own Transformers—Federal Power Corporation Advocated—Another Joint Committee

THE MAIN switchboard at Muscle Shoals was put into service Dec. 28. This will permit the simultaneous operation, under load, of the four generators that have been installed. With the switchboard in service it is expected that the line capacity away from Muscle Shoals will be occupied almost entirely by hydro power, although the steam plant will have to be kept in readiness to take over the load at any time during the testing period. While the capacity of the transmission line—85,000 kw.—is insufficient to take the maximum output of the four generators, there will be no occasion to operate all of them at capacity at the same time.

Three of these Westinghouse units were given their runaway test under the personal supervision of Col. Hugh Cooper. Each unit attained the requisite 100 per cent excess speed without difficulty.

If the four generators now in commission were operated so as to produce the maximum amount of power that can be taken away from Muscle Shoals, the government could realize $4,000 daily for the sale of the power.

Instead of the informal arrangement now existing whereby the government receives only two cents a kilowatt-hour for its power, it has been suggested that a better way would be to make a five-year contract. With assurance that deliveries of power would be continuous, a much better price would be obtainable. Next spring the additional output of the other four generators would be available.

This would make available many millions of dollars annually which could be expended in experimentation with nitrogen processes. Some regard that plan as much more desirable than attempting fertilizer manufacture at once when there is great uncertainty as to the success of any effort to fix nitrogen at Muscle Shoals on a large commercial scale.

The transformers now being used at Muscle Shoals are the property of the Alabama Power Co. It is General Taylor's intention to replace these with government-owned transformers at the earliest possible date.

New Bill for Operation of Muscle Shoals

A Muscle Shoals bill somewhat altered from his bill of the last Congress was introduced Jan. 5 by Senator Norris, of Nebraska. The measure separates the power and fertilizer operations at Muscle Shoals and proposes the creation of a Federal Power Corporation to have complete control of the power generated there. The corporation is to be administered by a Board of Directors, to be paid at the rate of $10,000 annually. The board is to consist of Morris L. Cooke, the director of the Giant Power Survey in Pennsylvania; James D. Ross, the superintendent and chief engineer of the Municipal Hydro-Electric plant at Seattle; and John R. Neal, of Knoxville, who is the chief opponent of the granting of private applications on the upper Tennessee River.

The corporation is authorized to build transmission lines and to sell power. In the sale of power preference is to be given to states and municipalities.

The nitrate plants, under Senator Norris' proposal, would be turned over to the Secretary of Agriculture. The power corporation will furnish electrical energy for the operation of these plants at cost.

Another Joint Committee for Muscle Shoals

By a vote of 248 to 27 the House of Representatives on Jan. 5 passed the resolution providing for further study of the Muscle Shoals problem by a joint congressional committee. The committee is to be composed of three members of the Senate Committee on Agriculture and three members of the House Committee on Military Affairs.

The committee is directed to conduct "negotiations for a lease of the nitrate and power properties of the United States at Muscle Shoals, including the quarry properties at Waco, Ala., for the production of nitrates primarily and incidentally for power purposes, in order to serve national defense, agriculture and industrial purposes and upon terms which so far as possible shall provide benefits to the government and to agriculture equal to or greater than those set forth in H. R. 518 (the original Ford offer), except that the lease shall be for a period not to exceed fifty years."

The committee is instructed to report not later than April 1 and "shall have leave to report its findings and recommendations, together with a bill or joint resolution for the purpose of carrying them into effect."

Representative Snell, the chairman of the Rules Committee, declared in the course of remarks supporting the resolution that it long has been the policy of the government to build a nitrate plant at Muscle Shoals. Its objective was not the creation of a power proposition.

Mercury Boiler in Commission at Hartford

The rebuilt mercury boiler of the Hartford, Conn., Electric Light Co. began productive operation again on Dec. 29 and is now delivering 22,000 lb. of steam per hour at 200 lb. pressure and 110 deg. superheat, while the mercury turbine is producing 1,500 kw. The mercury pressure has been raised to 48 lb. and will go higher. Commercial tests are expected in the near future.

Large Solid-Injection Oil Engines for Dredges

Two 720-hp. Fairbanks-Morse & Co. solid-injection oil engines are being installed in dredges at the New York Shipbuilding Corp., Camden, N. J., plant. Each engine has 6 cylinders, 16 in. diameter with a 20-in. piston stroke. The piston crowns are cooled by lubricating oil. Scavenging oil is supplied by a double-acting air pump mounted in line with the working cylinders and driven by a seventh crank on the engine shaft. These are the first of the large engines installed by the builder.

Edgar Station on Close to 1 Lb. per Kw.-hr. Basis

The new Edgar station of the Edison Electric Illuminating Co. of Boston, Mass., formerly called the Weymouth Station, is now operating on a coal rate of practically one pound per kilowatt-hour, the B.t.u. per kilowatt-hour in a recent run of one month being 14,350. The plant is but partly completed, and the greater part of its load has thus far been carried by one 30,000-kw. normal-pressure turbo-generating unit, the L Street Station in South Boston supplying the bulk of the system output. The 1,200-lb. boiler and turbine are now in part-time operation, although the maximum pressure has not yet been applied to the turbine installation.

The so-called normal steam pressure at the Edgar Station is 350 lb. It is anticipated from the results already obtained that the high-pressure unit in regular service will enable the station to produce a kilowatt-hour for 0.95 lb. of high-grade bituminous coal. The initial high-pressure installation is not a full development of the high-pressure possibilities in the Edgar Station, and the company expects that a full development of this equipment will bring the generating record of the plant down to 1 kw.-hr. for 0.9 lb. of coal.

Federal Control of Water Power Criticized

Senator Blease, of South Carolina, has advised the Senate that his state "has had just about enough of the Federal government's taking the water power and giving it to private corporations." He has had printed in the *Congressional Record* extracts from newspaper articles favoring public operation of water-power projects.

Senator Blease recently protested to the chief of engineers against the "giving away" of a water-power project on the Santee River. Senator Blease refers to the license recently issued to the Columbia Railway & Navigation Co. General Taylor, in response to the protest, informed the South Carolina Senator that it is his understanding "that Congress passed the Water Power Act to develop our latent water power and to authorize private persons to build and utilize power projects on the navigable waters of the United States, provided the requirements of the Act for the protection of the public are complied with fully."

Canada Added 719,000 Hp. New Installation in 1925

A preliminary report just issued by the Water Power Branch of the Canadian Government, shows that new installations during 1925 totaled 719,000 hp., bringing the generating capacity of the country up to 4,290,000 hp. Projects already under way will make a further addition of 250,000 hp. in the early part of the present year.

Quebec made the largest addition for the year, 438,300 hp., and Ontario came second with new installations of 200,000 hp. British Columbia added 58,984 hp. and Manitoba, 21,900 hp.

Reference is made to the fact that the year marked the coming into operation of certain huge power enterprises which have been in course of construction for some years. The most important of these are the Queenston development of the Hydro-Electric Power Commission on the Niagara River, with 500,000 hp. completely installed; and the Duke-Price Co.'s development on the Saguenay River in Quebec, with installation of 360,000 hp., out of an ultimate capacity of 540,000 hp. One of the most important developments now in course of completion is the 800,000-hp. project recently begun by the Aluminum Corporation of Canada at Chute-a-Caron on the Saguenay River in the Province of Quebec.

The year's progress in the various provinces is illustrated by the following statement of turbine installation at the beginning of this year and last, respectively:

	1925, Hp.	1926, Hp
British Columbia	355,722	414,706
Alberta	34,107	34,107
Saskatchewan	35	35
Manitoba	162,025	183,925
Ontario	1,585,182	1,784,932
Quebec	1,308,106	1,746,406
New Brunswick	44,656	44,656
Nova Scotia	63,957	64,202
Prince Edward Island	2,276	2,276
Yukon	13,209	13,209
Total	3,569,275	4,288,453

Governor Smith Again Calls Attention to Neglect of Water Power in New York State

Message Takes Up Public Ownership of Water-Power Resources—Control of Public Utilities—Sesqui Centennial

GOVERNOR SMITH, in his message to the Legislature of New York State on Jan. 6, had the following to say in regard to state water power resources:

No resource that the state possesses today has been so neglected as our great water power. We continue to generate from coal electrical energy for light, heat and power, particularly in our great centers of industry, while countless millions of cubic feet of water, capable of generating electric power, are running to waste. No private business institution in the world would tolerate such a condition. We have allowed nearly all of our natural resources to fall into private hands for private development and private profit. Water power is the last great one still in the hands of all the people.

Aside from the benefits that will come to the people of the state from water-power development, it is good business for the state itself. During the past year revenues to the state from the use of surplus canal waters have been materially increased, and it is worth noting that the rental of the power developed by the state itself at Crescent Dam and Vischer's Ferry represents 10 per cent upon the state's investment. All of our experience clearly demonstrates that we can make use of these great natural water-power resources for the benefit of the people and can do it with financial profit to the state itself.

Reorganization of the government makes necessary the abolition of the existing commissions dealing with water power and compels their functions to be performed by some one of the major departments of government named in the constitutional amendment just adopted. In my messages of 1924 and 1925, I advocated a definite, concrete plan. I would ask you to examine again those passages descriptive of the proposed creation of a State Water Power Authority. In conformity with the letter and spirit of the reorganization amendment, the Water Power Authority should be set up in the Conservation Department. I am certain that no sane or even reasonable argument can be made why these great water powers should remain undeveloped when a power agency, a quasi-public corporation, municipal in character, without stockholders, can be erected to develop the state's power resources without cost to our taxpayers. Neither the money nor the credit of the state need be pledged. No state bonds will be required. It does not mean that the state is going into the business of dealing in electrical energy. All that is required is that the state itself shall own, control and develop water power at the source.

Public-Utility Control

It is a fixed policy of the state to confer power upon local authority to settle all matters of purely local concern. In pursuance of that policy, the state should return to the municipalities the free hand they once had to deal for themselves with the corporations with which they made contracts at any time in the past. I was never able to find any fault with a policy of decentralization that would delegate to municipalities where they desired to exercise it, the right of the state to regulate all public utility corporations operating wholly within their borders.

Municipalities should also be free to supplement existing public utilities where their necessities require it without consent from the state, however desirable such a procedure may be in the case of private corporations. Municipal ownership is not new. Several cities of the state not only own but operate public utilities of various kinds.

Unquestionably, the incoming administration in the City of New York will have some recommendations to make to your honorable bodies concerning transit. Should the occasion arise, I will communicate with you on this subject at a later date.

The Sesqui-Centennial

Our neighboring states—Pennsylvania, Connecticut, Massachusetts and Vermont—are making preparations for commemorating the Sesqui Centennial. The historical and patriotic societies of the state and the people generally look to the government to make provision for a suitable celebration throughout the state during the year 1926. The regents of the university, by action of a special committee, reported a program. I respectfully call your attention to it and suggest that you give it your careful consideration.

American Engineers To Study Australian Brown Coal

W. H. Sawyer, of Columbus, Ohio, and H. W. Eales, of St. Louis, electrical engineers, will sail Feb. 2 for Australia to make a survey of electrical power resources in that country, Sir James Elder, Commissioner for Australia in the United States, announced on Jan. 5.

The two Americans have been appointed by the State of Victoria to officially investigate the Yellourn brown coal electricity generation plan and other power undertakings of the Government Electricity Commission.

Crude Petroleum Production Declined in November

The production of crude petroleum in the United States for the month of November, 1925, as reported to the Bureau of Mines, amounted to 61,658,000 bbl., a daily average of 2,055,000 bbl. This represents a decrease from October production of 21,000 bbl. per day, or 1 per cent. Of the seven districts the Rocky Mountain district was again the only one to show an increase in production, though declines were recorded in the states of Wyoming and New Mexico. Production in California continued to decline. In the Mid-Continent field the daily average production of Oklahoma was almost 500,000 bbl. per day, an increase over October of 13,000 bbl. This is entirely offset by a drop in Texas, the production of which has been steadily declining since early in the year. Of the total daily production of the country 43,748,000 bbl., or 70 per cent, was of light crude and 17,910,000 bbl., or 30 per cent, of heavy crude.

Stocks of crude oil east of California amounted to 296,690,000 bbl. on Nov. 30, 1925, a decline during the month of 1,270,000 bbl. This compares with 319,859,000 bbl. on hand Nov. 30, 1924, and is the lowest point in stocks since February, 1924. Most of the abovementioned decline was in refinery storage, which dropped off almost 1,000,000 bbl. In California stocks of both light and heavy crude (including all grades of fuel oil) continued their steady rise.

The production of lubricants increased, exports decreased, and stocks rose to 293,912,000 gal., a record high figure.

The production of gas and fuel oils fell off as runs to stills decreased. Stocks were reduced 70,000,000 gal. as demand for heating purposes increased.

Power Commission Outlines Colorado River Projects

Mr. Merrill secretary of the Federal Power Commission has outlined a plan for the handling of the Colorado River Project if it should be financed by the United States as follows:

PROJECT

The construction by the United States of a combined power and flood-control project on the lower Colorado River with a dam of from 400 to 500 ft. in height above river bed, with exact height and location so fixed as to permit of subsequent complete and economic development of the river above and below such dam, and as to obviate as far as practicable excessive losses of water by evaporation.

Project to include dam and control works, power house and high-tension substation. Sufficient excess storage capacity to be provided to protect lands below from flood damage.

DISPOSITION

Project to be licensed for a period of 50 years from data of completion under and subject to the provisions of the Federal Water Power Act.

Preference rights for license to be extended to municipalities, in accordance with the provisions of the Federal Water Power Act, either individually or in association, provided such association has an organized legal standing or is operating under a legally binding joint agreement. Properties to be licensed as a whole and not in part.

PLANS

Applicants for license whose proposals are accepted to be given preliminary permit for one year, during which time plans to be prepared and submitted for approval. In submitting such plans, applicant to present such maps and other data, including borings of dam sites, both of the site at which construction is proposed and other sites above and below, as to show that the plans prepared conform to the requirements of paragraph 1 hereof.

License to be issued only if the plans so conform, unless it can be conclusively shown that such conformity is physically or economically impracticable.

CONSTRUCTION

The construction work to be performed by the United States Reclamation Service.

OPERATION

Project to be turned over to licensee for operation upon completion of construction. Licensee to assume all costs of operation, including maintenance, repairs, replacement and the creation and maintenance of reserves adequate for offsetting accrued depreciation.

Maintenance of pool levels within the limits to be fixed in the license for flood-water storage, to conform to such requirements as may be specified from time to time by the United States Reclamation Service.

Cost of operation and maintenance of flood-control gates and equipment, if any, to be reimbursed to licensee by districts benefited thereby.

DIVISION OF COSTS

The cost of dam and control works, including work performed within the reservoir site and reasonable proportion of overhead and other general costs, interest during construction, etc., to be divided between power and flood control, so much of the aggregate cost being allocated to the former as would be necessary for building a dam for power purposes only and capable of producing an equivalent amount of useful energy.

The portion of such cost assigned to flood control to be payable to the United States with interest by the irrigation districts benefited, in proportion to such benefit and in the manner hereinafter provided.

The balance of the cost of the entire project to be payable in like manner by the licensee.

FINANCING

Project to be financed by special issue of federal government bonds payable in 50 years and callable in whole or in part on any interest date, such bonds to be sold as required to meet needs of construction. Interest on bonds accrued prior to delivery of properties to licensee to become a capital charge and to be paid out of the proceeds of the sale of bonds. Bonds to be repaid, principal and interest, as hereinafter provided. Such bonds not to be tax exempt.

Construction not to be undertaken until contracts executed with lessees and with irrigation districts obligating each to pay principal and interest on proportion of cost to extent and in manner herein provided.

PAYMENT OF INTEREST AND RETIREMENT OF BONDS

The irrigation districts and the licensee to make payment of principal and interest, each in the proportion of cost assigned as follows:

Beginning with the interest date next succeeding date of delivery of properties to licensee, interest on all outstanding bonds at the rate which such bonds bear to be paid semi-annually to the United States.

Beginning five years after such delivery of properties, there shall be purchased and delivered to the United States on each semi-annual interest date for cancellation bonds of such par value as added to the interest on bonds outstanding will produce approximately equal annual payments for the remaining years of the license period.

Licensees and irrigation districts to have option of delivering to the United States in lieu of such bonds any other bonds of the United States bearing an interest rate not less than the bonds issued on account of the project.

On receipt of project bonds the Secretary of the Treasury to cancel same, and on receipt of any other bonds of the United States delivered in lieu of project bonds the Secretary of the Treasury to call and cancel project bonds of the same par value. In order that the Secretary of the Treasury may know how many bonds to call for cancellation the license to specify, or give authority to the administrative agency to specify, not less than six months in advance of time of delivery, the amount to be delivered.

Any lapse in payment of interest on outstanding bonds by the licensee to subject the license to cancellation, also, any failure of the licensee during any five-year period to deliver to the United States the total of bonds required during such period. In case of such cancellation all rights of the licensee in properties to terminate.

Similar lapses by irrigation districts to forfeit any right to have reservoir operated in interest of flood control.

Either party liable for delivery of bonds to have option to deliver for cancellation at any interest date any quantity of project bonds in excess of required delivery which it may desire or, upon adequate notice, any amount of other bonds of the United States authorized for delivery in lieu of project bonds.

TITLE TO PROPERTIES AND RIGHTS

When all bonds issued on account of that proportion of the cost assignable to power have been delivered and canceled and all interest charges on the same have been paid, the properties constructed or acquired from the proceeds of the project bonds to become the property of the licensee, subject, however, if the irrigation districts have fulfilled their obligations, to the requirement forever to maintain available for flood control the prescribed storage capacity, or so much thereof as may be necessary for such purpose. Thereafter, the properties to be maintained and operated on lands of the United States under the provisions of the Federal water power act in the same manner as if the properties had been originally built at the expense of the licensee.

When all bonds issued on account of that part of the project cost assigned to flood control have been delivered and canceled, and all interest paid thereon, the right to have the storage capacity provided for flood control, or so much thereof as may be necessary, operated for the benefit of the irrigation districts participating in the cost thereof, shall become a vested right in such districts, and the obligation to maintain such capacity or so much thereof as may be necessary, available for such purpose shall be an obligation running with the project and superior to any other claim thereon, or right or interest therein, so long as such districts assume the duty or the cost of controlling such capacity for such purposes.

ALLOCATION OF POWER

In case of any dispute or disagreement between the licensee and any purchaser or prospective purchaser of power therefrom for distribution and sale to consumers respecting the allocation of power to such purchasers, and in case of any dispute or disagreement respecting the allocation of power to any state or group of states or to any municipality or group of municipalities, whether such power is transmitted and sold to consumers by the licensee or by a purchaser of power therefrom, the allocation of such power may, unless the matter comes within the jurisdiction of the public service commission of the state within which such a power is delivered or sought to be delivered, be heard and determined by the Federal Power Commission upon application by any party in interest, and any such determination to be binding upon the licensee and upon such purchaser; Provided, That neither the licensee nor such purchaser shall be required to make delivery of power in any specified territory except upon a finding by the Commission that the revenues to be received appear sufficient to afford to the licensee or to the purchaser, as the case may be, a reasonable reimbursement of the cost of delivery including a reasonable return upon the investment in plant or properties used and useful in effecting such delivery.

Oil Board To Hold Open Meeting

OPEN hearings, at which representatives of the oil industry will be invited to present views and data relating to American petroleum conditions, will be held early in February by the President's oil board, it is announced by Hubert Work, Secretary of the Interior.

The board's advisory committee, which has for months been studying replies made by the oil industry to questionnaires addressed to the leaders by the Federal Oil Conservation Board, has completed its work of digesting the replies and the result of its work will now be placed before the full board for its consideration. All phases of the oil industry — production, distribution, refining, possible substitutes, etc.—have been covered by leaders of the industry qualified to pass upon the practical and technical problems.

Weighing of Electricity Considered Feasible

Prof. John Ambrose Fleming, the British expert in wireless telegraphy, is quoted in the daily press as saying that it is now possible to talk of electricity in terms of weight, as if it were tea or sugar. His calculations, it is reported, showed that in a year the type of electric incandescent lamp ordinarily used in English households would consume about an ounce of electricity.

Army Engineer to Direct N. Y. Canal Bureau

Major Thomas F. Farrell, Corps of Engineers, United States Army, was named on Jan. 4 Commissioner of Canals and Waterways in the New York State Department of Public Works, at $10,000 a year, to succeed Royal K. Fuller who has resigned.

In a statement announcing the appointment Colonel F. S. Green, superintendent of Public Works said that Major Farrell is thirty-five years old, was born at Brunswick, Rensselaer County, and was graduated from the Rensselaer Polytechnic Institute with the degree of Civil Engineer. From 1913 to 1917 he was an engineer on the Panama Canal. In August, 1917, he sailed for France with the 1st Engineers. He has been instructor of engineering at Fort Humphrey and at West Point, his present post.

River Development Thought Power Commission Function

In a report to the Committee on Interstate and Foreign Commerce of the House of Representatives the Federal Power Commission approves proposed legislation to grant the United States Geological Survey adequate funds for preparing an inventory of water resources, but it opposes the granting of general authority to the Survey to prepare comprehensive plans of water development for all purposes.

"The preparation of general plans of river development," says the Commission in its report, which is signed personally by each of the three Cabinet members comprising the Commission, "not only requires the appraisal and use of the fundamental physical data but it involves also consideration of economic factors and of specialized data which belong to the specific fields of development, such as irrigation, water power and navigation which must be co-ordinated in any general plan. No single governmental agency has all this specialized information in its possession, or can secure it without extensive and wholly unnecessary duplication of the activities of other agencies. The problem of irrigation in its construction and administrative phases, is being handled by the Bureau of Reclamation. The responsibility of the United States in matters of navigation has been the exclusive function of the War Department. Since the passage of the Federal Water Power Act the activities and interests of the Departments of War, Interior and Agriculture with respect to water power have been co-ordinated through — not performed by — the Federal Power Commission.

"The Commission is of the opinion that only through the co-ordinated action of the three departments interested will it be practicable to prepare general plans which would adequately solve the problems or receive public confidence. It believes any proposal to place the function of the preparation of the general plans of river development upon a single agency, and particularly upon an agency having no administrative responsibility over any of the uses for which it would prepare such plans, would be most unwise."

This bill, H. R. 6358, "To Provide for an Inventory of the Water Resources of the United States and for Other Purposes," which was introduced into the House on Dec. 22 by Mr. Newton, of Minnesota, was referred to the Committee on Interstate and Foreign Commerce. It provides that the Director of the Geological Survey be authorized to make within a period of twenty years, "an inventory of the water resources of the United States to include data that will be required in making a comprehensive plan for developing both surface and ground waters for domestic and industrial supplies, irrigation, navigation, power and other uses and for conservation and control of flood water. The bill provides for co-operation of the different federal, state or private enterprises under governmental control and carries an appropriation of $400,000 to be available until June 30, 1927, and $500,000 for each of the nineteen years remaining.

The amendment to the bill proposed by the three secretaries simply eliminates from this bill the provision that the inventory of water resources is to include "data that will be required in making a comprehensive plan for developing both surface and ground waters for domestic and industrial supplies, irrigation, navigation, power and other uses and for conservation and control of flood waters."

Nipigon River Has 200,000 Hp. Potentialities

When all the potential energy of the Nipigon River in Ontario is developed it will, according to O. Holden, produce 200,000 hp. The head available is 244 ft. The existing plant develops only 45,000 horsepower.

Senate Asks Treasurer for Anthracite Tax Figures

The Senate, by unanimous consent, called on the Treasury Department on Jan. 5 for information on tax returns made by companies mining anthracite. The resolution, which was introduced by Senator LaFollette, follows:

Resolved, That the Secretary of the Treasury be, and he is hereby, authorized to furnish to the Senate a statement based on corporation income tax returns covering the year 1924, showing for each corporation engaged in the mining of anthracite the amount of capital stock, the amount of invested capital, the amount of net income, the amount charged to depletion and depreciation of accounts and the amount of federal tax paid by each such corporation.

Tennessee River Licenses May Also Be Suspended

A resolution suspending the right of the Federal Power Commission to issue licenses on the Tennessee River was introduced by Senator Norris, of Nebraska, on Jan. 4. He pointed out to the Senate that the resolution follows the line of that of Senator Pittman, dealing with the Colorado River, which already has been approved by that body. Senator Norris' position is that no disposition should be made of rights on the river until it is known what is to be done with the government's properties at Muscle Shoals.

Senator McKellar, of Tennessee, in discussing the matter on the floor of the Senate, reiterated that the Corps of Engineers had favored private interests in the dissemination of information concerning the general survey of the Tennessee River. This was contested by Senator Underwood, of Alabama, who ventured the opinion that Senator McKellar is mistaken in those conclusions.

"The General Electric Co.," Senator McKellar told the Senate, "has gone down there and has undertaken to gobble up this water power. I here and now, in my place in the Senate, protest as vigorously as I know how against the unseemly haste on the part of the War Department and of the Federal Power Commission. Evidently, they are afraid that in some way Congress may stop the proceedings."

The Norris resolution was referred to the Agricultural Committee of which Senator Norris is chairman. It is believed that he will be able to secure a favorable report, but the probabilities are that the Senate will not act on this resolution without extended debate. Even if passed by the upper House, the chances seem to be against the legislation in the House.

Tennessee River Basin Has Heaviest Rainfall in U. S.

Evidence that the power development at Muscle Shoals will serve a high degree of usefulness because of abundant rainfall in the Tennessee River area has been furnished in a scientific study by William E. Barron, meteorologist of the U. S. Weather Bureau. At the meeting of the American Association for the Advancement of Science Mr. Barron gave the results of his investigations. He said:

The Muscle Shoals district is a portion of the Tennesse River lying between Decatur and Florence, Ala., where the river widens and plunges forward with a descent of 126 ft. in 32 miles. The hydro-electric development of the district has been begun by the erection of Wilson dam, just above Florence, with a height of 102 ft. and capable of producing 624,000 hp. The pool above the dam extends upstream 15 miles to the proposed site of Dam No. 3, which will back up the water almost to Guntersville, 54 miles above Decatur. No storage is expected beyond the maximum pool stage; this will depend on further development upstream.

The average annual precipitation over the area is 52 in. or more—14 in. each in winter, spring and summer and 10 in. in autumn, making this one of the best-watered interior regions in the United States.

Colorado River License Suspension Opposed

That the House of Representatives will not act hastily on the Pittman resolution, which suspends the authority of the Federal Power Commission to issue licenses on the Colorado River, is assured by its reference to the Committee on Interstate and Foreign Commerce. This action was not taken without deliberation. There was demand that it go to the Committee on Irrigation of Arid Lands, where a favorable report probably would have been forthcoming in short order. The Public Lands Committee which handled water power matters prior to the formation of the water power act, also was a contender for the bill. While the public lands are involved in the development of 90 per cent of the available water power in the country, the conclusion of the Speaker was that the development of power is more a matter of interstate commerce.

Some predict that the resolution never will emerge from the committee, as it is believed a majority of its members do not want to see restored the embargo on power development which existed for ten years prior to the enactment of the water power act.

The Pittman resolution passed the Senate so shortly after it was reported out of committee that no opportunity for protest was afforded. Since that action, however, Congress has learned that there is opposition to the measure. In addition to those who do not want to see the Water Power Act set aside, even for short periods in restricted localities, those who are interested in financing water-power development do not want to see the act whittled away just as the financing of projects under it is beginning.

Missouri School of Mines Adds Clay Working Course

The Missouri School of Mines and Metallurgy at Rolla, Mo., is to add a new department of ceramics or clay working, which is expected will be opened next fall. The need for instruction in the handling of clay at a school situated in the center of one of the largest clay-producing areas in the United States has been felt for some time, said Dr. Charles A. Fulton, director of the School of Mines. It remained for a committee composed of representatives of the clay industry in Missouri to meet and bring the matter before the curators of the school, he said.

Missouri is at present the second state in the Union in its yearly clay production. Missouri clay deposits have hardly been scratched; they will last for centuries to come, yet all our ceramic experts, the men who direct the working of the raw clay, have to be obtained from Eastern schools.

An example of the importance Missouri plays in the clay industry was given by J. Harrison Brown, chairman of the Clay Industrial Committee. He said that "diaspore" a type of clay discovered a short while ago, which contains great resisting qualities and has high aluminum content, can be mined in commercial quantities in Missouri alone. No other state has been able to produce it profitably. This type of clay is used in lining the interiors of furnaces which must withstand great heat, he said.

New Jersey Loses Its Suit Against Power Commission

The effort of the State of New Jersey to have the Federal Water Power Act declared invalid through a suit against the Federal Power Commission, the attorney general and other officials came to naught Jan. 4, when the United States Supreme Court, in a decision by Justice Van Devanter, dismissed the bill on the ground that no case of controversy appropriate for the exercise of judicial decision was presented in the suit. The dismissal sustained the position of the federal government in the case.

The federal government had filed a motion to dismiss the New Jersey suit on the ground that no issue was presented, but only an abstract question respecting the relative authority of Congress and the state in dealing with navigable waters.

In its decision, the Supreme Court points out that the state had failed to show that any right it possesses is being or is about to be affected prejudicially by the application or enforcement of the Federal Water Power Act in New Jersey. It was not shown that the Federal Power Commission is about to do anything in New Jersey to affect the interests of the State, nor is it shown that the state itself intends to do any definite thing which might be objected to by the Federal Commission, the decision states. New Jersey has talked of plans for developing water power on the Morris Canal, but has no definite project in definite form in that respect, the decision points out. The court concludes, therefore, that the suit does not present any concrete issue for judicial determination by it.

Draftsmen Needed by the Navy Department

The United States Civil Service Commission announces the immediate need for additional design, detail and copyist draftsmen for hull work at the New York Navy Yards. Full information and application blanks can be obtained from the secretary of the second United States Civil Service district, Custom House, New York City.

Electrical Engineers Will Consider Trends for 1926

The New York Section of the A.I.E.E. will at its Jan. 29 meeting devote its attention to the analysis of the "Trend of the Electric Light and Power Industry." A critical analysis of the conclusions reached by the essayists in the Bonbright Prize Essay Contest will be given. Robert M. Davis, statistical editor of the *Electrical World*, will analyze the quantitative trend of the industry, including interpretation of 1925 figures and definite predictions for 1926. Horace P. Liversidge, vice-president of the Philadelphia Electric Co., will discuss the technical trend of the industry, technical possibilities and probabilities. John F. Gilchrist, vice-president of the Commonwealth Edison Company, of Chicago, will discuss the commercial tendencies and the problem of raising the load factor, and will present his views on the commercial outlook from all its various angles. Harold V. Bozell, of Bonbright & Co., Inc., will give a short discussion on where the money is coming from to finance the growth of the industry in the years ahead.

Personal Mention

Hubert E. Collins has severed his connection with the Syracuse office of Anthracite Coal Service, an anthracite operators' organization, and has resumed his consulting engineering practice at the Winston Bldg., Utica, N. Y.

Dr. D. S. Jacobus, a past-president of the A.S.M.E. and advisory engineer of the Babcock & Wilcox Co., is to be the official representative of the A.S.M.E. at the inauguration of Dr. Kolbe as president of the Brooklyn Polytechnic Institute on Jan. 13, at the Opera House of the Brooklyn Academy of Music.

W. A. Kreider, who for 30 years has been manager of the Chicago office of the Ball Engine Co., recently left the city to spend some time at the home of his parents in Monroeville, Ohio. Owing to ill health Mr. Kreider previously had resigned his position. His many friends in the mechanical field regret exceedingly to part with so able an engineer and all wish him a speedy recovery.

J. E. Davidson, vice-president of the Nebraska Power Co. and now president of the N.E.L.A., in recognition of his service to Nebraska and the electric light and power industry, was tendered a dinner at the Hotel Fontenelle, Omaha, on Dec. 30, which was attended by 150 enthusiastic electric light and power men. The career of Mr. Davidson in the electrical industry, it developed, began in the boiler room of the power plant at Port Huron, Mich., his first job being that of machine oiler and meter reader.

Society Affairs

An International Oil Exhibition is to be held at the Crystal Palace, London, April 21 to May 8. During the exhibition it is expected that an International Petroleum Congress will be held.

The Connecticut Section of the A.I.E.E. will hold a meeting at Hartford on Jan. 19, at which "Maintenance of Industrial Equipment" will be the subject and F. D. Hallock, of the Westinghouse company, the speaker.

The Houston, Texas, Section of the A.S.M.E. will hold its Jan. 19 meeting at the University Club at 8 p.m. The subject that will be considered will be "Pulverized Fuel," by E. T. Keck, superintendent of power of the Texas Power & Light Co.

The Engineers' Society of Western Pennsylvania will hold its annual banquet on Jan. 25 at the William Penn Hotel, Pittsburgh, Pa. Guy E. Tripp of the Westinghouse company, George E. Roberts, National City Bank, and Williard Scott will be the speakers.

The Plant Engineers' Club, Boston, Mass., will visit the Charlestown Navy Yard on Jan. 13 at 2.30 p.m. In the evening Mr. Wheelock, of Wheelock, Dean & Bogue, will give an illustrated talk on the "Unit Pulverizer," following the usual supper at the Boston City Club.

Business Notes

The McClave-Brooks Co., Scranton, Pa., announces that it has discontinued its Scranton district territory and has incorporated this territory with the Philadelphia office with George Blair, Jr., as district manager.

Newell, Corse & McDaniel, 706 Otis Bldg., 810 Eighteenth St., Washington, D. C., announce the continuation of their consulting business under the name of The Research Service, Inc., at the same address.

The American Steel & Wire Co., 208 South La Salle St., Chicago, Ill., announces that George D. Kirkham, sales agent of the company at Memphis, Tenn., has retired from active service with the company after about forty years of service.

The Boiler Engineering Co., 760 Broad St., Newark, N. J., announces that J. W. Putnam, formerly with the Engineer Co., New York City, as manager of the baffle wall department, is now associated with the company as general manager. This company has placed on the market the Beco baffle.

The Garratt-Callahan Co., Chicago, Ill., manufacturers of "Magic" Boiler Preservative, announces that it is moving its Chicago office to 310 South Michigan Ave. A. H. Baker, vice-president and general manager of the company, is in charge of this office, with A. H. Hawkinson as sales manager.

The Earle Gear & Machine Co., Philadelphia, Pa., announced the sale of the Earle centrifugal pump department of the company to the Aldrich Pump Co., Allentown, Pa. The company will continue to manufacture the Earle cut gears, bridge-operating machinery, special machinery and Lea-Simplex cold metal saws.

Trade Catalogs

Buckets — The Hayward Co., 50 Church St., New York City. Bulletin 656 describes the orange peel buckets for hoists.

Valves—Wilson - Snyder, Pittsburgh, Pa. Folder describing the solid and hollow forges and cast ball valves manufactured by the company.

Meter, Air Leakage—The Elliott Co., Jeannette, Pa. Bulletin C-4 describes the device for measuring the air leakage in a surface condenser.

Motors — The Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin 1132 describes types "AR" and "ARY" polyphase induction motors with cast-steel frames and Timken tapered roller bearings.

Valves—The Elliott Co., Jeannette, Pa. Bulletin K-1 describes, with tables of dimensions, etc., the Faber self-cleaning blowoff valves. Bulletin S-7 covers Lagona non-return valves for ordinary- and high-pressure and high-temperature service.

Air Compressors — Pennsylvania Pump & Compressor Co., Easton, Pa. Duplex single-stage and two-stage cross-compound air compressors, class "DB" and "DE," are described in a new bulletin, Form No. 126, recently issued by the company.

Electric Drives—Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Motor application circular 7381, "Electric Drives for Power Plant Auxiliaries," is a well gotten up booklet presenting in a clear and concise fashion information regarding the machines and motors and their operation.

Mills, Pulverizing—The Hardinge Co., York, Pa. Catalog No. 13A describes the conical ball and pebble mills and their application to the field of grinding and pulverizing. Well illustrated with photos and drawings as well as with tables of dimensions, the catalog should prove of value to anyone desiring this type of equipment.

Transformers, Instrument—The General Electric Co., Schenectady, N. Y. Bulletin GEA-178, recently issued, covers instrument transformers. Besides general descriptions the purpose and application curves on performance of the different types and tables of instrument transformer burdens are given.

Diesel Engines—Nordberg Manufacturing Co., Milwaukee, Wis., Bulletin No. 39 illustrates "where Diesel engines have solved power problems." Typical installations as applied to stationary and marine service covering a wide range of sizes are cited, with operating data and experience to show what degree of satisfaction the various units have given.

Coming Conventions

American Boiler Manufacturers Association—Meeting at City Club, Cleveland, Ohio, Feb. 12.

American Engineering Council, L. D. Wallace, 26 Jackson Place, Washington, D. C. Annual meeting at Washington, Jan. 14-15.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engineering Building, New York City, Feb. 8-12.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Oil Burners Association. Leod D. Becker, 350 Madison Ave., New York City. Annual convention and exposition at Book Cadillac Hotel, Detroit, Mich., April 6-8.

American Petroleum Institute—R. L. Welsh, 250 Park Ave., New York City. Annual meeting at Biltmore Hotel, Los Angeles, Calif., Jan. 19-21.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 20-22.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Annual meeting at Hotel Statler, Buffalo, N. Y., Jan. 27-29.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

Association of Municipal Electric Utilities. S. R. A. Clements, 190 University Ave., Toronto, Canada. Convention at Toronto, Ont., Jan. 27-28.

Engineering Institute of Canada. Richard John Durley, 176 Mansfield St., Montreal, Que. Annual meeting at Toronto, Ont., Jan. 27-29.

Heating & Ventilating Exposition. E. P. Frenz, Hotel McAlpin, New York City. Exposition at new Madison Square Garden, New York City, Mar. 17-23.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Mason City, Iowa, Jan. 27-29.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, American Exposition Palace, Jan. 26-30.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

Sesquicentennial International Exposition. Capt. Asher C. Baker, director in chief, Independence Square, Philadelphia. Exposition to be held in Philadelphia, Pa., from June 1 to Dec. 1.

Society of Automotive Engineers. Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at the General Motors Bldg., Detroit, Mich., Jan. 26-29.

Western Association of Electrical Inspectors. W. S. Boyd, 175 West Jackson Blvd., Chicago, Ill. Meeting at Hotel Sherman, Chicago, Ill., Jan. 26-28.

Material Handling—Robins Conveying Belt Co., 15 Park Row, New York City. Catalog No. 65 is a cloth-bound volume covering the material handling equipment manufactured by the company. The book is divided into fourteen sections, one section for each type of conveying equipment handled. Many illustrations, drawings and tables enrich the descriptions.

Gages, Recording — Defender Automatic Regulator Co., 308 South Eighth St., St. Louis, Mo. Bulletin No. 50 describes recording pressure and vacuum gages made with suspended pen arms in moisture- and dust-proof cases. Bulletin No. 35 covers standard Fortine type mercurial barometers, mercury column vacuum gages, manometers. Catalog No. 7 is a pocket catalog containing short descriptions of the instruments made by the company.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; **mine run** except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Jan. 4 1926
Pool 1	New York	$2.75@$3.15
Smokeless	Boston	1.88
Clearfield	Boston	1.75@2.25
Somerset	Boston	1.85@2.35
Kanawha	Columbus	1.55@1.85
Hocking	Columbus	1.75@2.00
Pittsburgh	Pittsburgh	2.00@2.10
Pittsburgh gas slack	Pittsburgh	1.50@1.60
Franklin, Ill.	Chicago	2.35@2.65
Central, Ill.	Chicago	2.25@2.35
Ind. 4th Vein	Chicago	2.25@2.35
West Ky.	Louisville	1.25@1.50
S. E. Ky.	Louisville	1.40@1.75
Big Seam	Birmingham	2.00@2.25
Anthracite, Gross Tons		
Buckwheat No. 1	New York	$2.50@$2.75
Buckwheat No. 1	Philadelphia	2.50@3.00
Birdseye	New York	....

FUEL OIL

New York—Jan. 7, light oil, tank-car lots; 28@34 deg. Baumé, 5@5½c. per gal.; 36@40 deg., 5¾@6½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Dec. 29, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 5.53c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Jan. 5, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Jan. 2, f.o.b. local refinery; 26@30 deg., $1.55 per bbl.

Philadelphia—Dec. 29, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.75@$1.81; 13@19 deg., $1.68@$1.74 per bbl.

Boston—Dec. 21, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4.55c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati — Jan. 5, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 6⅝c. per gal.; 26@30 deg., 7c. per gal.; 30@32 deg., 7¼c. per gal.

Chicago—Jan. 5, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.40@$1.45.

New Plant Construction

Calif., Colusa—Reclamation District 1004, is having plans prepared for the construction of a pumping plant, 2 units including two 12,000 g.p.m. automatic control screw pumps, etc. C. W. Levisee, 627 Jay St., is engineer.

Calif., Los Angeles—Sun Realty & Investment Co., 742 South Hill St., awarded contract for the construction of a 12 story office and stores building at Seventh and Flower Sts., to McNeil Co., 5960 South Park Ave. $1,215,00.

Calif., Los Angeles—Warner Bros., c/o G. A. Lansburgh, Consolidated Bldg., Archt., had plans prepared for the construction of a 6 story theatre, office and stores building at Wilcox Ave. and Hollywood Blvd. Estimated cost $1,500,000.

Calif., Nestor—Tia Juana Irrigation Dist., is having plans prepared for the construction of a pumping plant and reservoir 40 ft. high x 600 ft. long, etc. Estimated cost $200,000. J. V. Covert, National City, is engineer.

Calif., Oroville — Hammon Engineering Co., Insurance Exchange Bldg., San Francisco, is having preliminary plans prepared for the construction of a hydro electric power development to generate electricity in connection with Oroville-Wyandotte Irrigation Dist. taking waters from south fork of Feather River and Dry Creek in Butte County to develop either 69,170 hp. or 75,028 hp. here. Estimated cost $4,000,000. S. J. Norris, is engineer.

Calif., San Francisco — Marian Realty Co., 110 Sutter St., plans the construction of an 8 story hotel and theatre building at O'Farrell and Leavenworth Sts. Estimated cost $1,000,000.

Calif., Van Nuys—Bd. of Education, will soon award contract for the construction of a high school including 30 x 40 ft. boiler house. Estimated cost $150,000. A. Neher, Insurance Exchange Bldg., Los Angeles, is architect.

Conn., Derby—Derby Gas & Electric Co., 22 Elizabeth St., will soon award contract for the construction of a 3 story factory including boiler room on Housatonic Ave. Estimated cost $50,000. R. W. Foote, 185 Church St., New Haven, is architect. Electrical equipment including transformer, meter room equipment and elevators will be purchased.

Conn., Waterbury—Lux Clock Co., 97 Sperry St., is receiving bids for the construction of a 5 story factory including 50 x 120 ft. power house. T. M. Freney, 51 Leavenworth St., is architect.

Fla., Miami—All States Society Assn., 10th St. and 2nd Ave., plans the construction of a hotel. Estimated cost $2,000,000. Day & Zimmerman, Sixteenth and Walnut Sts., Philadelphia, Pa., are architects.

Fla., Miami Beach (Miami P. O.)—G. R. K. Carter, 15 Ocean Drive, plans the construction of a 20 story hotel at Ocean Drive and Bucayne Ave. Estimated cost $2,500,000. R. A. Preas, Metropolitan Bldg., Miami, is architect.

Ill., Bloomington — City plans improvements to water and light plant. Black & Veatch, 700 Mutual Bldg., Kansas City, Mo., are engineers.

Ill., Chicago—M. H. Callner, 177 North State St., will build a 12 apartment at 426 Surf St. Estimated cost $1,500,000. R. Gregori, 155 North Clark St., is architect. Owner is general contractor.

Ill., Chicago—Chicago City Bank & Trust Co., 62nd Place and Halsted St., is having plans prepared for the construction of a 6 story bank and office building at 63rd and Green Sts. Estimated cost $1,000,000. A. Epstein, 2001 West Pershing Road, is architect.

Ill., Chicago—Passavant Hospital, c/o R. Tyson, 53 West Jackson Blvd., is having preliminary plans prepared for the construction of an 8 or 9 story hospital at East Superior St. and Fairbank Court. Estimated cost $1,500,000. Holabird & Roche, 104 South Michigan Ave., are architects.

Ill., Chicago—M. S. Plotke, 111 West Washington St., is having plans prepared for the construction of an 8 story apartment at 4240-4248 Clarendon Ave. Estimated cost $1,500,000. Huszargh & Hill, 6 North Michigan Ave., are architects.

Ill., De Kalb—Illinois Power Co., A. D. Mackie, Gen. Mgr., Springfield, plans the installation of a new boiler and appurtenances in the light and power plant here, also additional underground installation of power lines at Springfield. Estimated cost $127,000 and $79,800 respectively.

Ind., Evansville—Mead-Johnson Co., 200 St. Joseph Ave., will build a power plant stack 220 ft. high, 2 turbine generators, stokers, etc. Estimated cost $90,000. W. E. Briggs, Knoxville, Tenn., is engineer.

Ind., Hammond — Hotel Ambassador Corp., North State St., Chicago, Ill., is having plans prepared for the construction of a 9 story hotel here. Estimated cost $1,000,000. B. H. Jillson, 6 North Michigan Blvd., Chicago, Ill., is engineer.

Ky., Louisville—Kentucky Hydro Electric Co., plans the construction of a 2,000 kw. hydro electric plant at Lock 7 on the Kentucky River. L. F. Harza, 53 West Van Buren St., Chicago, Ill., is engineer.

Mass., Rowe—New England Power Co., 35 Harvard St., Worcester, awarded contract for the construction of a power unit here to Sherman Power Construction Co., 35 Harvard St., Worcester. Estimated cost $40,000.

Mich., Detroit—Dept. of Public Works, will receive bids until Jan. 13 for the construction of a pump pit and suction well, furnishing and installing centrifugal pumps, motors, electrical equipment, etc., for Lonyo Road pumping station. P. A. Fellows, is engineer.

Mich., Detroit—S. S. Joy, 2001 West Pershing Road, Chicago, Ill., Archt., will receive bids until Jan. 15 for the construction of a 6 story warehouse and office building at 10th and Fort Sts. for Coe Terminal Warehouse Co., 429 Wayne St. Estimated cost $1,000,000.

Mich., Detroit—The Maccabees, A. W. Frye, Supreme Commander, Shelby and Congress Sts., awarded contract for the construction of a 10 and 14 story office building including steam heating equipment on Woodward Ave., to H. G. Christman Co., 315 Stevens Bldg. Estimated cost $2,500,000.

Minn., Minneapolis—Eitel Hospital, G. C. Eitel, Prop., plans additional buildings including a power plant at 14th and Willow Sts. Estimated total cost $850,000. P. E. Crosier, 915 New York Life Bldg., is architect.

Minn., St. Paul—Ramsey County, G. J. Ries, Co. Auditor, will receive bids until Jan. 18 for two tubular wells for pumping water into Lakes Josephine and Gervais, also plans the construction of pump houses and installation of pumping equipment later. Total estimated cost $15,000.

Miss., Vicksburg—City Ice Co., plans the construction of an ice plant. Estimated cost $50,000 including machinery. J. L. Blackwell c/o owner will supervise construction.

Mo., Marionville — Marionville Cold Storage Co., W. D. Hawley, Secy., will soon receive bids for the construction of a 4 story addition to cold storage plant, including 2 compressors, etc. Estimated cost $85,000. Heckenlively & Mark, 642 Landers Bldg., Springfield, are architects.

Mo., St. Louis—City, E. E. Wall, Director, will soon receive bids for the construction of a 20 unit, 80,000,000 gal. filtration plant including filter house, head house, equipment, etc., at Howard's Bend waterworks plant on Missouri River. Estimated cost $1,225,000.

Mo., St. Louis—Syndicate of Physicians, c/o O. J. McCawley, 616 Chestnut St., will soon receive bids for the construction of a 10 story office building on Washington St. Estimated cost $600,000. LaBeaume & Klein, Compton Bldg., is architect.

Neb., Lincoln—State Board of Control, Capitol, Lincoln, will build a power plant, including boiler house, etc., by prison labor. Estimated cost $100,000. Consulting Board Engineers, c/o owner, are engineers.

N. Y., Ashford—Niagara, Lockport & Ontario Power Co., has applied to the Public Service Commission, Albany, for permission to make extensions to electric plant.

N. Y., Gowanda—The Depew & Lancaster Light, Power & Conduit Co., has applied to the Public Service Commission, Albany, for permission to construct an electric plant here to serve the towns of Gowanda, Dayton, South Dayton, Randolph, East Randolph and Perrysburg.

N. Y., New York—The Hotel Properties, Inc., D. A. Shulte, Pres., c/o Warren & Wetmore, 16 East 47th St., Archt., is having plans prepared for the construction of a 20 story hotel at Madison Ave. and 52nd St. Estimated cost $2,500,000.

N. Y., New York—New York Life Insurance Co., 346 Broadway, awarded contract for the construction of an office building at Madison Ave. and 26th St. to Starrett Bros., Inc., 292 Madison Ave. Estimated cost $10,000,000.

N. Y., New York—Three Hundred Eight West Eighty Six Street Corp., c/o Deutsch & Schneider, 35 Maiden Lane, Archts., is having plans prepared for the construction of a 15 story apartment at 303-307 West 86th St. Estimated cost $500,000.

N. Y., Yonkers—M. S. Construction Co., c/o W. Katz, 6 Hudson St., is having plans prepared for the construction of an apartment at South Yonkers. Estimated cost $500,000.

O., Cincinnati—Hamilton County, plans the construction of a sanitary sewer and pumping station at Brockell Park subdivision. Estimated cost $31,644. L. C. Boyatt, Court House, is engineer.

O., Cleveland—City, A. K. Hoare, Comr. of Purchases and Supplies, will receive bids until Jan. 15 for coal larries, hydraulic ash elevator, boiler feed pumps and feed water heaters.

O., Columbus—Dept. of Welfare, J. E. Harper, Dir. Ninth and Oak Sts., will receive bids until Feb. 1 for coal handling equipment, conveyor 50 tons per hour, 60 ft. long and crusher 50 tons per hour for Cleveland State Hospital, Cleveland.

Okla., Ponca City—Ponca City Milling Co., is receiving bids for the construction of a mill, warehouse, office building, and power plant. Horner & Wyatt, 646 Board of Trade Bldg., Kansas City, Mo., are engineers.

Pa., Etan (Pittsburgh P. O.)—Wilkinsburg Ice Co., 208 Center Ave., Wilkinsburg, is having plans prepared for the construction of an ice plant here. Estimated cost $200,000. Private plans.

Pa., Philadelphia—J. Rabinowitz, 37th and Walnut Sts., plans the construction of a 13 story apartment at 23rd and Walnut Sts. Estimated cost $700,000. J. Margolis, 1505 Race St., is architect.

Tex., Amarillo—City is having plans prepared for improvements to waterworks including a 3,000,000,000 gal. storage reservoir, 5,000,000 gal. distribution reservoir, six 5,500,000 gal. total capacity, shallow wells, six 1,000 g.p.m. deep well and two 3,000 g.p.m. horizontal pumps, 500,000 gal. tank on 150 ft. tower, etc. Estimated cost $1,750,000. H. B. Jones, is engineer.

Tex., Canyon—City plans an election Jan. 11 to vote $15,000 bonds for improvements to waterworks including pumping equipment, mains, etc. C. M. Harrison, City Hall, is mayor.

Tex., Dallas — Petroleum Building Co., c/o T. R. Lee, 1405 Second National Bank Bldg., awarded contract for the construction of a 21 story office building at Texas Ave. and Austin St. to Hickey & Harrington, 808½ Commerce St. Estimated cost $2,000,000.

Tex., Elgin—Texas Power & Light Co., Interstate Bldg., Dallas, has acquired the Elgin Light & Power Co.'s plant and plans additions and improvements including machinery here. Private plans.

Tex., Marshall—East Texas Public Service Co. c/o K. Lee, Mgr., is having plans prepared for the construction of a 70 ton ice plant. Estimated cost $150,000 including machinery. Private plans. Owner will purchase machinery later.

Tex., Vernon—Vernon Electric & Ice Co., subsidiary of the Texas Central Power Co., Frost Bldg., San Antonio, awarded contract for the construction of addition to ice plant. Additional ice-making machinery will be installed. J. Marriott, Frost Bldg., San Antonio, is engineer.

Ont., Toronto—North American Life Insurance Co., 112 King St. W., plans the construction of a 6 story office building, including steam heating and vacuum systems, elevators, etc., on Yonge St. Estimated cost $1,000,000. Sproatt & Ralph, 1162 Bay St., are architects.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

The current market for power-plant supplies shows advances in prices of such items as packing and wiping cloths, compared with a month ago. Cotton waste, linseed oil and babbitt metal are slightly lower than on Dec. 8. Steel pipe quotations have not changed since 1922. Market for electrical supplies is steady with next move probably in a downward direction.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, sing'e jacket		71c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list less	45%

Air—Best grade

¾-in., per ft.	3-ply	$0.37½	4 ply	$0.46

Steam—Discounts from List

First grade 30-10% Second grade 40% Third grade 40-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade 50% Second grade 50-10%

LEATHER BELTING—List price, 24c., per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40%
Heavy	30-10%

RAWHIDE LACING For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ¼ in.	$1.05
Asbestos for high-pressure steam, ½ in.	1.85
Duck and rubber for piston packing	1.05
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.95
Wire insertion asbestos sheet	1.40
Rubber sheet	.60
Rubber sheet, wire insertion	.85
Rubber sheet, duck insertion	.65
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@ $2.70 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	15.00@22.00	19.00	20.00
Colored	10.00@15.50	10.00	17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.15½
New York	.18
Cleveland (per thousand)	36.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.93¾	$1.10	$0.99

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$15.25	$15.75	$16.75	$17.25
White	15.25	15.75	15.25	15.75

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, 7/16x1-in. and longer, 19c. per lb., less 50% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1¼ to 2-in. long, all diameters, 25c.; ⅝-in. dia., 35c.; ¾-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ¾, ⅞, 1 in. diameter by 2½ in. to 4½ in. sell as follows per 100 lb.:

New York $5.00* Chicago $3.50 Pittsburgh $2.60

Boiler rivets, same sizes:

New York $5.20* Chicago $3.70 Pittsburgh $2.90

* For immediate delivery from warehouse.

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$48@53
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	23@28
Chrome cement, 40@ 50% Cr_2O_3, in sacks	net ton	27@32
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and splits	per ton	91.00@95.20
Silica brick: N. t. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@47
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@45
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	48@50
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	33@40
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	40@43
Clay brick, 2nd quality 9 in. shapes, Maryland	per M	43@45
Chrome ore crude, 40@ 50%	net ton	19.00@20.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	80.62½
Commercial genuine, intermediate grade	56.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	14.50

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.00	$3.90	$3.60
Flats, squares and hexagons, per 100 lb. base	4.50	4.40	4.10

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19.20
1½	.....	$38.00	17.92
1¾	.....	28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3¼	.....	49.50	30.67
3½	31.50	52.75	33.33
4	38.03	67.00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3½ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$36.00 (net)	$56.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:	Lead Covered
Less than coil lots—50%	20%
Coils to 1,000 ft.—55%	25%
1,000 to 5,000 ft.—60%	30%
5,000 ft. and over—60–5%	35%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50.13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508.50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG, SOLID NEUTRAL OR 2 FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID NEUTRAL OR 2 FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$23.00
No. 16 cotton reinforced heavy	26.50
No. 18 cotton reinforced light	18.10
No. 16 cotton reinforced light	22.00
No. 18 cotton Canvasite cord	16.75
No. 16 cotton Canvasite cord	19.10
No. 16 super service cord or similar (2 wire)	101.20
No. 14 super service cord or similar (2 wire)	146.40

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 65%; standard package, 70%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP OR CLEARSITT—

0-30 ampere, standard package (500)	$2.85
0-30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.32	120	50	$0.40	$0.45	60
15	.27	.32	120	75	.45	.55	60
25	.27	.32	120	100	.50	.55	24
40	.27	.32	120	150	.65	.70	24
50	.27	.32	120	200	.80	.85	24
60	.32	.37	120	300	1.25	1.35	24
				500	2.00	2.15	12
				750	3.50	3.70	8
				1,000	3.75	3.95	8

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75.00 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	08½

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$7.20	$9.95	$11.80	$18.50
12	10.25	12.98	14.97	24.55
10	13.50	16.90	18.90	31.76
8	18.90	22.90	24.40	42.75
6	.....	.....	35.00	.....
4	.....	.....	47.85	.....
2	.....	.....	68.75	.....
1	.....	.....	89.65	.....
0	.....	.....	120.16	.....
00	.....	.....	142.20	.....
000	.....	.....	169.90	.....
0000	.....	.....	202.67	.....

SOCKETS, BRASS SHELL—

⅛ In. or Pendant Cap Key Each	⅛ In. or Pendant Cap Keyless Each	⅛ In. or Pendant Cap Pull Each	¼ In. Cap Key Each	¼ In. Cap Keyless Each	¼ In. Cap Pull Each
$0.36	$0.33	$0.50*	$0.42	$0.39	$0.56*

Less 1-5th standard package	30%
1-5th to standard package	40%
Standard package	45%

* Net.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 35c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 37c. lb., 100 lb. lots	35c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%